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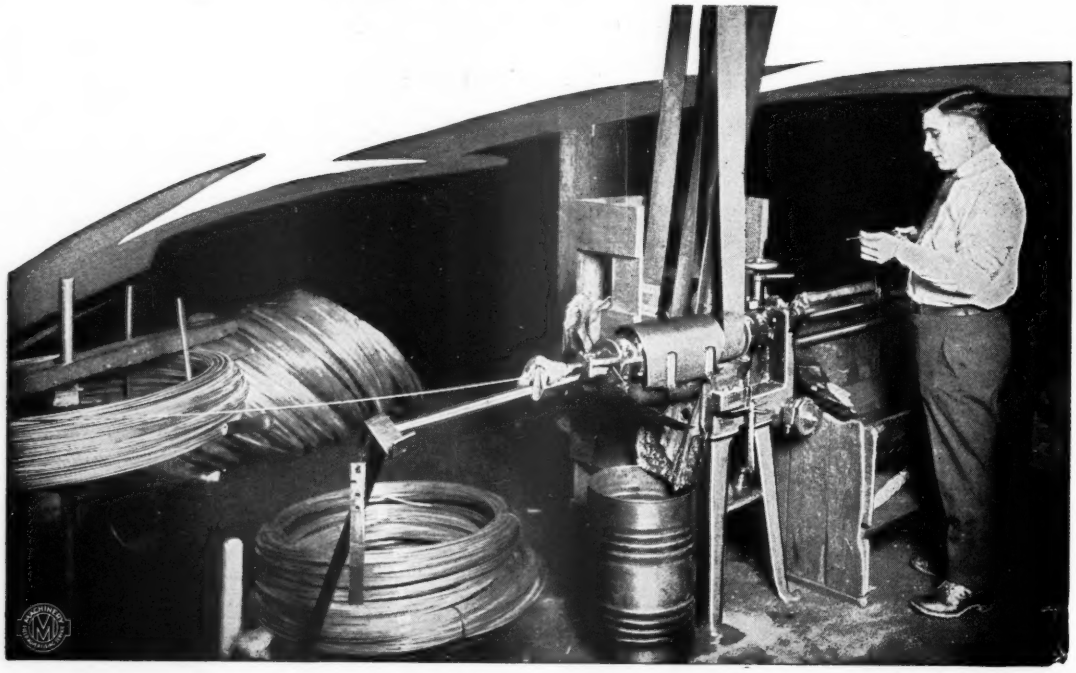

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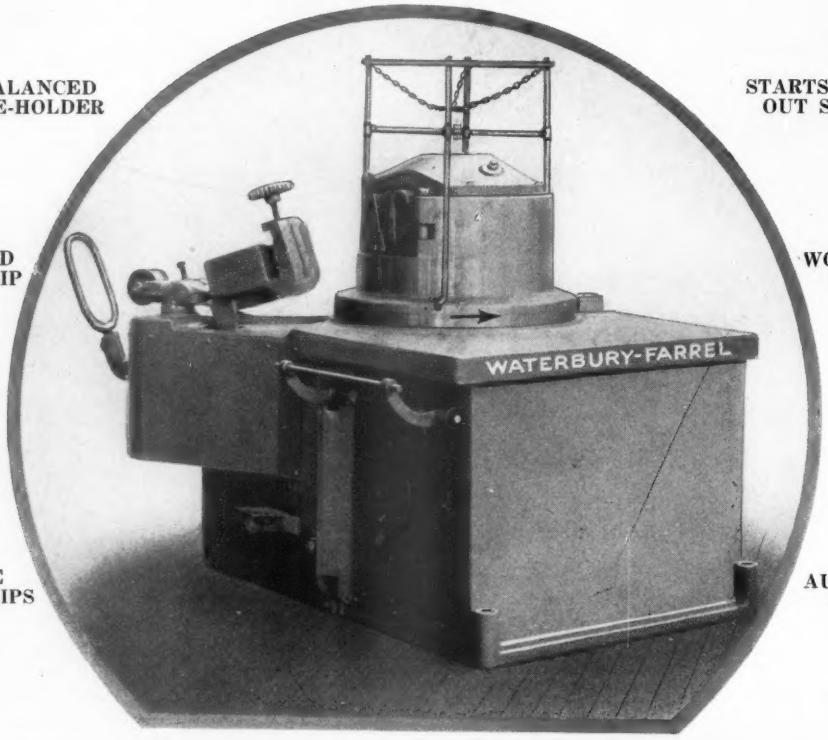

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THE directory of the wire industry to be published by us in the fall will mark a great step forward in establishing more efficient and economical traffic within the industry. This directory will list every manufacturer of wire and wire rod and wire products. These will be classified according to the type of metal or nature of the fabricated product. All ferrous and non-ferrous wire and rod manufacturers will be represented. Among manufacturers of wire products will be listed all makers of wire rope, cable, insulated wire, springs and the thousands of domestic and industrial articles made largely or entirely of wire.

In addition the directory will list all manufacturers of machinery for drawing, straightening, coiling and other working of wire. Heat treating equipment will be completely represented.

The handling and conveying of wire is receiving close attention from industrial engineers and manufacturers of cranes and conveyors will also be classified in the directory.

For the information of plant managers the directory will index all sources of accessory materials such as pickling acids, soaps, oils, coatings, annealing salts, etc.

An exhaustive list of makers of wire drawing dies of every description will be included.

All these as well as a large number of other items will be arranged in one classified system with every item cross indexed under all possible heads.

* * *

An important feature of the Directory will be a complete index of all material appearing in Wire & Wire Products magazine to the date of publication of the Directory. This index will list not merely titles and authors of articles but a thorough analysis of all smaller subjects treated in the text. Such an index should be a valuable reference to all drawers and fabricators of wire and will serve as a guide to all literature on wire. *The Publishers.*

WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 2 July, 1927 No. 7

Contents

The Manufacture of Swedish Wire Rods, By N. Danielsen - 223

Winning Preferred Space for a Commonplace Product - - 225

Wire Mesh Protecting Bricklayers - - - - - - 225

The Relation of Steel Quality to the Drawing of Steel Wire, Part II, By E. A. Atkins - - - - - - 226

Making of Wire Rods, By George A. Richardson - - 230
Improved methods and machinery in the Sparrows Point plant of the Bethlehem Steel Co.

The Galvanization of Iron and Steel, By Dr. H. Altpeter - 233

Foreign Trade in Wire—Strong German and Belgian Competition in Central and South America - - 238

Exports of Copper Wire - - - - - - - - 238

Woven Wire Netting, By M. A. Hall - - - - - - 239
Details of manufacturing process—
Large and growing industry—Foreign competition.

Hard Drawn Copper - - - - - - - - - 243
Its mechanical properties—Useful data.

Domestic Exports of Iron and Steel Wire, Wire Rope and Wire Nails from the United States - - - 246

Buyers' Guide - - - - - - - - - - - 254

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WIRE
& WIRE PRODUCTS

Vol. 2 JULY, 1927 No. 7

The Manufacture of Swedish Wire Rods

By N. Danielsen

General Sup't, Hellefors Steel Works, Hellefors, Sweden.

WHAT are the main features of Swedish Wire Rods, and what are the reasons why they are sent all the distance from far away Sweden for cold drawing in U. S. A.?

The Editor of this magazine has asked me to give an answer to these questions. I shall be happy to do my best, though I shall have to go into some details.

Charcoal Pig Iron

The entire manufacture of Swedish high quality steel is based on charcoal pig iron. This should be borne in mind, when a comparison is made between Swedish Wire Rods and rods of other manufacture. The charcoal pig iron, as it is made in Sweden, is of rare purity and uniformity. In our small blast furnaces, which seldom have an annual output exceeding 8,000 tons, you will find that an analysis with regard to phosphorus, sulphur, manganese and silicon can be kept practically constant month after month and year after year. The total absence of sulphur in Swedish charcoal and the negligible amounts of sulphur and phosphorus in Swedish iron ores make the pig iron suitable for refining by the acid process. A steel maker has thus the great advantage of a raw material of constant composition. The low figures for phosphorus and sulphur do not call for refining by a basic process, whereby oxides easily are introduced into the steel.

Small Units of Production

Whether the pig iron is converted into steel by the electric or by the Siemens Martin acid process it will be noted that only small units are used. The average furnace capacity is not above 15 tons. To an American steel maker this might appear ridiculously small. Though steelmaking in Sweden has been carried on for hundreds of years and you often find that art and skilfulness have been kept on the same level for generations from father to son, Swedish steel makers are anything but conservative. In fact, a visitor to a Swedish steel works will be surprised at the up to date equipment with regard to machinery and the modern research methods used by the mills. If the steel industry of Sweden today, when there is general trend throughout the world for amalgamation and expansion, still believes in moderate sized units, this must be based on strong reasons. Quality calls for care, constant inspection and a close cooperation between steel producer and steel consumer. Quality steel is ordered in a great variety of analyses, very often in small quantities and almost always to narrow physical and analytical limits. On these points of view, generally adopted in Sweden, the steel industry has been organized and brought to a high level.

Wire rods are formed out of the ingot by rolling to billets, which are then reheated and turned out to wire rods. The rolling of billets is of minor interest, as it is made in the same manner practically everywhere. I shall not go into details of this stage of manufacture but pass on to the rolling of wire rods.

The Swedish wire rod mill, which is specially constructed for rolling high carbon wire

rods, is rather different from a commercial mild steel wire rod mill. According to Swedish practice the billets pass a cogging mill, generally three high, where the billets are brought down with very slight pressures from say 4" to a rod of a thumb's thickness. The hot rod, which is now of considerable length, passes on to a mill operated at high speed and often consisting of 6 to 10 stands. By every pass the rod is slightly reduced and shifted from one pass to another to some extent by skilled workmen, who have to constantly watch the temperature of the rod. The result is a rod finished at a proper temperature to assure fine grained structure not only in one part of the coil but through the entire length. A remarkably close tolerance of size can also be obtained by this method.

Uniformity and Weight of Coils

There is a general call today among wire drawers for increased weights of coils. This is quite natural, as operating costs are considerably reduced when handling heavy coils compared to the lighter. However, the attention should be drawn to the fact that such heavy coils from necessity cause a reduced uniformity of microstructure of the steel. A broader tolerance of size must also be given the rod mill. This is due to the fact that the difference in finishing temperature between the first and the last end of the wire rod increases with increased weight of coils. In such cases, where the wire drawer starts drawing high carbon steel rods without annealing or normalizing and when it is a question of best quality, it does not seem advisable to order Swedish wire rods in weights of coils much exceeding 125 lbs. If a normalizing treatment is given the rods before starting drawing, coils of 175 to 200 lbs. should give good results.

Figures below represent best Swedish practice on unalloyed wire rods rolled to No. 5 B. W. G. in coils of around 100 lbs.:

% Carbon	Ultimate strength lbs. per sq. inch	Elongation on 2 inches	Reduction of area %
0.15	57,000	36	75
0.20	62,000	34	71
0.30	72,000	30	65
0.40	84,000	26	58
0.50	94,000	23	52
0.60	105,000	20	45
0.70	116,000	17	39
0.80	125,000	15	34
0.90	132,000	12	29
1.00	135,000	10	24
1.10	136,000	9	19
1.20	135,000	8	15

Though straight carbon steels still form the bulk of Swedish rods, all kinds of alloyed rods are nowadays brought into this country from Sweden. These rods have found a market preferably on account of their uniformity of analysis and absence of surface defects such as blisters, seams and decarbonization.

It is quite natural that a merchandise, which is made to such high standard and to rigid demands, must be treated as a specialty and cannot be sold on the same price level as ordinary grades of wire rods. The natural resources of Sweden, its abundance of waterpower, charcoal and good ores, its high technical standard and its skilled labour form the base, on which Sweden, in spite of long distance and in many cases high import tariffs can send its wire rods all over the world. It is especially a great satisfaction to the old country to be able to contribute to the success of American wire products by supplying its most selected steel in consciousness of the fact that quite a number of the best wire drawers of this country originate in Sweden.

Some Applications

For what purposes are Swedish wire rods used? To begin with mild steel, there is quite a tonnage going for articles where a low electric resistance is of vital importance. It might not be generally known that Swedish Charcoal Iron can be supplied at a resistance less than 4675 mile ohm. The coercive force of such iron is around 0.7 in a field of 150 c: g. s. Wire of this kind is used for electrical instruments, fuse wire and in some cases, where resistance to corrosion is important, for telegraph wire. Mild steel wire, low in carbon and manganese, is chosen for very flexible wire ropes which are wound around discs of small diameter compared to the diameter of the rope. It is here the question of fatigue-stresses emanating from repeatedly bending the rope. The life of thousands of American citizens depend on the reliability of elevator ropes of Swedish origin.

An important article for the textile industry is Card Clothing. Without absolute uniformity in the wire rods it is impossible to obtain a wire possessing the stiffness and the elasticity that is so essential in this product.

Towards Improvement in Rope Making

The bulk of the world's output of steel wire nowadays is said to go for rope manufacture. In spite of scientific methods and a broader technical knowledge, which have contributed to raise the quality of steel ropes, there is a trend for a still better rope. Swedish steel with its high ultimate strength combined with remarkable toughness and resistance against fatigue is very often chosen for making ropes for the industry, for aeroplanes and for naval cables. Though a great variety of rustless steels are known today, Swedish steel is often preferred by rope manufacturers for the reason that it

(*Continued and page 246*)

Winning Preferred Space for a Commonplace Product

FOR many years the Chain Products Company, of Cleveland, Ohio, recognized the fact that there were a number of obstacles to prevent them from merchandising their product aggressively. In the first place, the average consumer was not chain conscious; when he wants something to attach to a movable or stationary object, he usually thinks of a rope or cord. Compared with rope or cord, chain is of comparatively recent origin.

Another reason why chain had never become more than a prosaic article of commerce was that most hardware dealers usually had their chain stock down in the basement, or under a counter, so that a direct request for a chain was about the only way they ever had it brought to their attention, or even so much as let their customers see it.

It was for the purpose of bringing chain out into the full view of the public that the company recently determined to design a rack to accommodate three of the most popular sizes of chain patterns and to supply these racks to dealers through the hardware jobbing trade. The rack itself is an ingenious contrivance which can be hung against the wall or against a post, and, by the use of a simple attachment, it can also be used as a counter rack.

Before deciding definitely to make such a radical departure from the established methods of selling chain, however, officials of the company took into consideration the fact that display stands, merchandising features and other devices of a similar character were becoming increasingly common. It was a matter of debate, they realized, whether or not these advertising innovations were not a bit overdone.

A Peg For Advertising

"Particularly is this true of the prominence given many items of merchandise which really are not necessary," declares Charles M. Luthy, sales manager of this company, "articles which fall in the category of non-essentials. If dealers generally would accept and place on exhibition all of these contrivances, their establishments would have the appearance of an Oriental bazzaar.

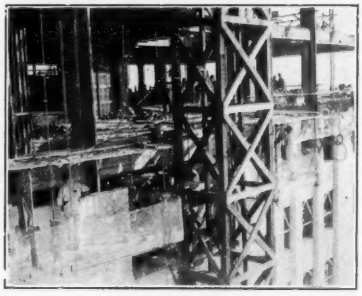
"Following the introduction of this rack, a sample of it was mailed free to the buyers of various hardware jobbing concerns. Our advertising plan for the year was built around the rack, and both trade paper copy and direct-mail efforts are properly synchronized. In the carton with the rack mailed to jobbers are included sufficient reprints of our cover page advertising in one of the prominent hardware publications to equip each of their salesmen with a copy. This ties up perfectly with the direct-mail and other paper advertising, as mentioned.

"Jobbers everywhere are expressing a keen interest in this new merchandising feature. In checking the results of their experience, we found that the most effective way they have adopted to cash in on our efforts is to mount a reel of chain on the rack and exhibit it at their salesmen's meetings."

Reprinted from **Sales Management.**

Wire Mesh Protecting Bricklayers

Proves more effective than Canvas.



IN the erection of high buildings the old rule that prevailed was, "A LIFE FOR EVERY STORY ERECTED," on a steel frame building. This rule was eliminated in the construction of the twenty-six story Pacific Telephone & Telegraph Company building in San Francisco, as there were not only "no fatalities" but there was not a serious injury to any of the workmen, a record which is thought never to have been equalled.

This remarkable record was due principally to the complete system of safeguards that were provided throughout the building by the builders and contractors, Lindgren & Swinerton Company. Determined to do everything possible for the safety, security and welfare of their workers, the contractors engaged a well-known safety engineer, Mr. J. J. Rosedale to install every safety feature possible, with the result that scores of safety features were installed throughout the building.

As shown in several of the accompanying photos, the scaffolds used by the brick-layers and terra-cotta-layers were protected ou the outer edge by means of heavy wire screen and a cable ½-inch in diameter and toe-boards which effectively prevented bricks from falling off the platform. The heavy wire screen permitted a maximum of light to enter and effectively prevented the workmen from falling. As is known canvas is usually used for this purpose, but canvas shuts out the light and is not near as strong and substantial as heavy wire screen.

The Relation of Steel Quality to the Drawing of Steel Wire

PART II

By E. A. Atkins, M. I. Mech. E.
Warrington, England

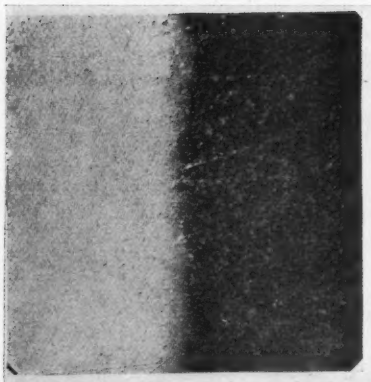


FIG. 13.—Butt-weld formed of 0·60 and 0·05 per cent. carbon wires, drawn from 5 gauge to 12 gauge after welding in the rod form. ×100.

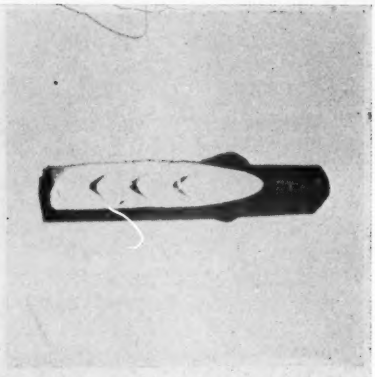


FIG 14.—Piece of ¼-inch diameter wire, showing incipient cups. (Natural size.)

Segregated Steel

IT is not uncommon to find that certain portions of a cast of hard steel have segregations at the core of the rods which, unless the greatest possible care in drawing is exercised, lead either to complete or incipient fractures. The photograph (natural size) of a longitudinal section of a piece of ¼-in. diameter wire, Fig. 14, reveals four incipient cups, showing that the wire in drawing had regularly broken at the core, whilst the outside remained intact.

This type of defect in steel is illustrated by the cementitic segregation shown in the micrograph Fig. 15, and also by core fractures as shown in a piece of wire, Fig. 16. Where the core is of a pronouncedly hard type the centre portion of the wire in drawing will break into cups, which may be only about ⅛ in. apart, as shown in Fig. 17. Wire of this description is, of course, useless, and dangerous if put into service.

It may be contended that this "cuppiness" can be somewhat obviated by taking very light drafts (or reversing the wire after each draft in drawing), but the steelmaker should remember that it is impossible to examine every piece of rod and subject it to a special treatment to suit its particular peculiarities. Material should be of such a quality that it will give a good quality wire when subjected to the standard practice in wire-drawing.

When steel billets are segregated, as shown in the sulphur prints, Figs. 18 and 19, the segregation will inevitably be found in the core of the resulting wire, whatever gauge it may be drawn to, and though for some purposes there is no very serious disadvantage in the use of the wire, such material is almost useless for heading or similar work. This is illustrated by a sulphur print of a section of headed bolt, Fig. 20, in which the stresses set up by the flowing of the steel when cold-headed may be so severe as to cause the material to separate at the neck under very light pressure, or the head itself may split across its centre at right angles to the axis of the bolt. Hard wire drawn from segregated steel, it can readily be understood, is not the best quality to use for ropes.

A mild steel rod when segregated often shows a structure the outside area of which is quite diverse from the inside. This is illustrated in Fig. 21, in which the structure of the material near the surface of the rod is shown on the left, whilst that of the core is shown on the right side of the micrograph. In the latter part large sulphide inclusions and also the massive formation of pearlite may be seen.

In the same manner a high-phosphorus material containing ghost lines, as shown in

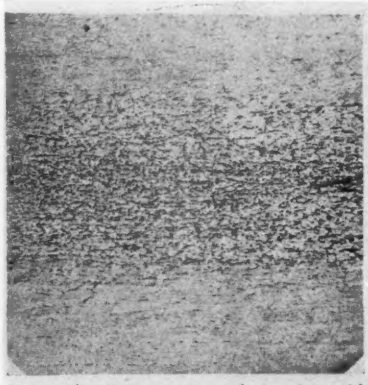


FIG. 15.—0·45 per cent. carbon wire with cementitic core. Etched with sodium picrate. ×50.

FIG. 16.—Core fracture through cementitic segregation. ×100.

longitudinal section in micrograph Fig 22, and also in cross-section in Fig. 23, will cause all sorts of trouble by splitting or breaking when worked up into wire in the cold. As is well known, the banded lines are not easily removed by any ordinary method of heat treatment, but in this connection it may be of interest to examine the structure of a specimen both before and after heat treatment. Fig. 24 shows the banded structure in a rod, whilst Fig. 25 exhibits the structure after it has been subjected to a temperature of 950°C. for 3½ hours and cooled slowly for a period of five hours. It will be observed that though the banded structure has been broken up the grains are very large. In any case, it is well to remember that in the treatment of ordinary material abnormal methods of manufacture cannot possibly be adopted to suit varying kinds of steel.

Surface Defects and Hollowness

Laps or spills on wire may be caused through a bad surface on ingots, due either to splashes in casting or skin blow-holes. Defects may be caused during the rolling of the billets into rods by overfilling the grooves, which sets up fins. Fine cracks on billet edges due to a bad composition of steel or to overheating may cause roaks, which result in either broken wirt or damaged surface. Insufficient cropping to remove "pipe" will result in producing defective rods or hollow wire, which in cases is useless.

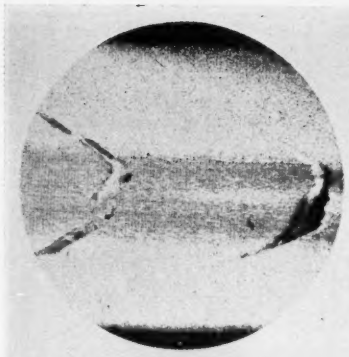


FIG. 17.—Core fractures in wire, about $\frac{1}{8}$ inch apart. ×20. (Reduced to $\frac{2}{3}$.)

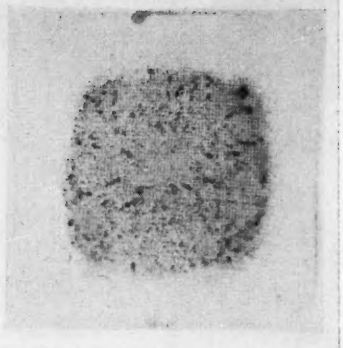


FIG. 18.—Sulphur print of billet.

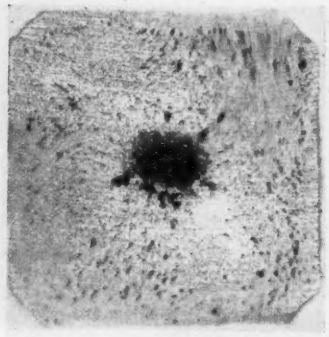


FIG. 19.—Sulphur print showing pronounced segregation.

FIG. 20.—Sulphur print of section of headed bolt.

Effect of Non-Metallic Inclusions

Slag inclusions in steel, besides causing trouble in drawing the wire to correct sizes, may also result in the necking down of the wire at the parts where the slag inclusions are segregated as groups (Fig. 10). Fortunately, this is not a very common phenomenon, but it may occasionally occur if very dirty steel of the particular type shown is used.

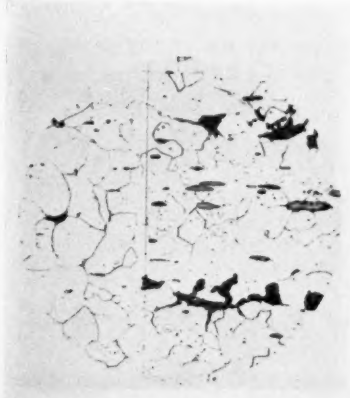


FIG. 21.—Left, structure at surface of rod; right, centre of rod with sulphide globules and massive pearlite. (Reduced to $\frac{2}{3}$.)

FIG. 22.—Ghost lines in wire. ×100. (Reduced to $\frac{2}{3}$.)

The Cause of Wire "Running Out" or not Sizing Correctly

Formerly continual disputes arose between the wire manufacturer and the steelmaker as to why some classes of steel, whether acid or basic, could not be drawn correctly to size, the wire sometimes sizing so badly that one end of a 150-lb. piece might be 17 gauge and the other end 16 gauge or larger. This meant that the wire in passing through the conical hole of the wire-drawer's plate gradually ground or pulled out the hole until it was one or more gauges larger in diameter by the time the complete piece had passed through, the resulting wire, of course, being tapered from end to end. Whilst the wire-drawer blamed the steel, the steelmaker attributed the trouble to some defect in the wire-drawer's plate, machinery, or process in connection with the manufacture.

However, many years ago, an examination of the surfaces of evenly drawn and defective wires furnished a clue to the trouble. It was found that the

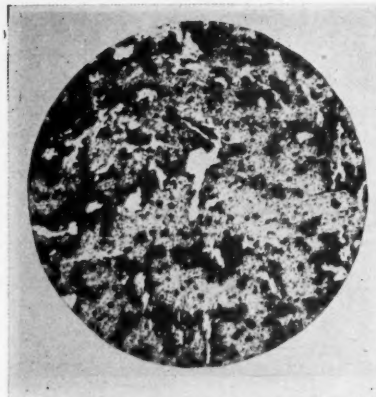


FIG.—23.—Section of wire showing the ends of high-phosphorus threads. ×100 (Reduced to $\frac{3}{11}$.)

FIG. 24.—Banded structure in wire. ×100. (Reduced to $\frac{3}{11}$.)

one which drew even-ended had fine, unbroken drawing lines on the surface (Fig. 26), whereas the drawing lines on the surface of the wire which "ran out" were broken up, the appearance being somewhat similar to a ploughed field in which the furrows had been trampled down by a herd of cattle (Fig. 27). This led to a search for the cause of the breaking up of the drawing lines. Examination of the polished, unetched surfaces of the steels which drew badly indicated the presence of very minute specks of non-metalic material. When drawn into fine wire, it was found that the specks were still present in the steel in their original form, thus showing that they were intensely hard and could not be elongated. A polished longitudinal section of such a wire is shown in Fig. 28. The tails at the sides of the specks indicate not only the direction of polishing but the hardness of the inclusions. After careful calculation it was found that this form of fine non-metallic speck was present in the steel sometimes to the extent of 140,000 to the square inch, or about 50 million to the cubic foot.

Many subsequent examinations of billets, rods, and wire gave fairly accurate information as to the amount that the respective materials would "run out" in wire-drawing. Thus the mild steel shown in the micrograph Fig. 29, which exhibited about 40,000 specks to the square inch, increased in diameter 10 mils during the last pass when being drawn to 14 gauge, which made the wire 14 gauge at one end and 13 gauge at the other.

The Nature of the Hard Inclusions

An investigation has been

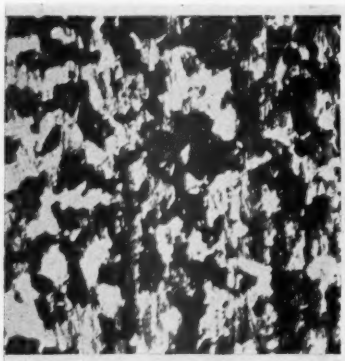


FIG. 25.—Banded structure in wire after annealing at 950° C. ×100. (Reduced to $\frac{3}{11}$.)

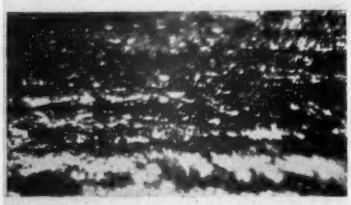


FIG. 27.—Broken drawing lines on wire. ×100.

carried out to discover the nature of the inclusions which cause the most trouble in drawing wire to the correct size. The first material dealt with was a hard steel with 0.65 per cent. carbon. The history of its manufacture was unknown, but it ran out of size very badly when drawn into wire. Examination of a 5-gauge rod showed the specks to be of rather large size, as shown in the micrograph Fig. 30.

Examination at a higher power showed that the inclusions were crystalline in form, being apparently transparent. Two of them are shown in Fig. 31, whilst the micrograph Fig. 32, at a still higher magnification, shows one crystal clearly and a second one partially removed from its position in the solid metal by polishing. This micrograph also shows an enlarged view of part of the polishing tails.

A steel was chosen which was definitely "specky" in character, and by following a method somewhat similar to that of Dickenson[1] it was completely dissolved, and the residue collected, which when examined under the microscope was found to contain some transparent crystals in a conglomerate mass. This was subsequently treated with hydrofluoric acid, which removed the silica but had no apparent action upon the crystals. The residue of crystals when placed on a micro-slide and examined under the microscope appeared as shown in Fig. 33. These were later dissolved, subsequent an-

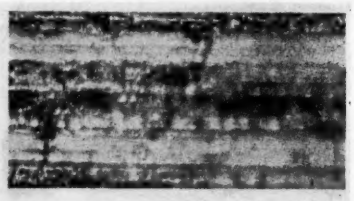


FIG. 26.—Drawing lines on wire. ×100.

FIG. 28.—Longitudinal section of wire showing specks. ×100.

1.—Jl. of Iron & Steel Inst., 1926, No. 1, p. 177

alysis showing them to be composed of alumina.

The great hardness of the crystals was readily shown by lightly pressing a piece of glass upon them and moving it laterally, the result being that the surface of the glass was scratched.

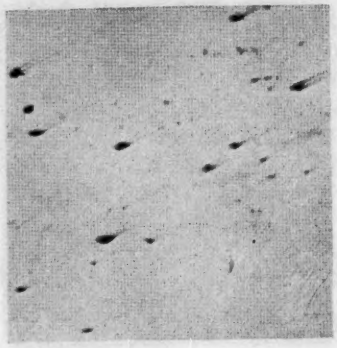


FIG. 29.—Specks in mild steel wire which caused it to "run out" 10 mils in 14 gauge. ×100.

It can be appreciated that such hard crystals of alumina embedded in the steel have a great abrasive power in grinding the hole larger in the wire-drawer's plate. It has, of course, long been known that when aluminium is added to steel it causes trouble in "running out" in wire-drawing, but it is somewhat peculiar to find that the alumina takes the crystalline form as illustrated.

It was thought that it would be of interest to add definite amounts of aluminium to particular types of steel, to examine these carefully and note the actual results in wire-drawing. First of all, a basic hard steel with 0.65 per cent. carbon and 0.55 per cent. manganese was made, 3.7 oz. of aluminium to the ton being added as the steel was run into the ingot mould. This when examined in the billet form, after polishing only, exhibited specks as shown in Fig. 34. When drawn into wire it "ran out" 7 mils whilst being taken down to 17 gauge.

An ingot of the same cast which had no aluminium added to the mould was shown to be practically clean when polished, only one speck appearing on a definite area. This when drawn down to 17-gauge wire was, for all practical purposes, level ended, "running out" less than half a mil in a 160-lb. piece.

A cast of mild steel with 9.3 oz. of aluminium to the ton added to the ingot mould also showed specks, this "running out" no less than 10 mils (more than a gauge) when drawn down from 5-gauge rod to 16-gauge wire.

Another mould of the same cast of mild steel had 19 oz. of aluminium to the ton added, the billets of this when examined showing an enormous number of specks, as appears in Fig. 35 In attempting to draw this to wire it was found impossible to size at all, as the hole of the drawplate was almost immediately ground out.

Samples of all the above steels were dissolved and examinations were made for the presence of the hard crystals, and in each of the "specky" materials these were discovered.

Whether the alumina is wholly in the crystalline form, or

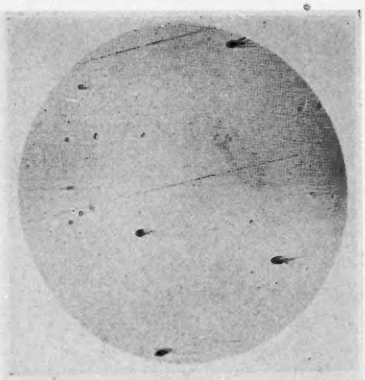


FIG. 30.—Section of 5 gauge rod (0·65 per cent. carbon), showing large specks which cause "running out." ×100. (Reduced to ¼.)

partly amorphous, is difficult to say, and in any case it is only of academic interest. One thing is certain, namely, it is in the hard vitreous form, which of course is the cause of its great abrasive action.

It was thought that crystals of alumina might be found in the residue of cisterns of hydrochloric acid in which large quantities of "specky" rods had been

(*Continued on page 252*)

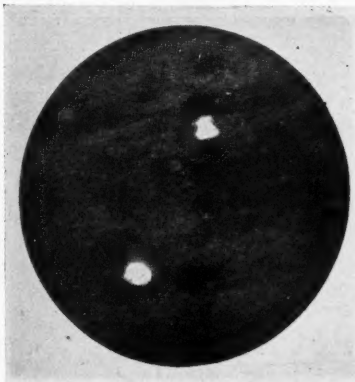


FIG. 31.—Two of the specks shown in Fig. 30, illustrating their crystalline character. ×1000. (Reduced to ¼.)

FIG. 32.—One complete crystalline speck and one broken one. ×1500. (Reduced to ¼.)

FIG. 33.—Separated crystals on a glass slide. ×100. (Reduced to ¼.)

FIG. 34.—Specks in steel due to the addition of aluminium. ×100. (Reduced to ¼.)

Making of Wire Rods

Improved methods and machinery in the Sparrows Point plant of the Bethlehem Steel Co.

By George A. Richardson

THE Maryland Plant of Bethlehem Steel Company at Sparrows Point, Maryland, has recently put into operation a Rod and Wire Mill of the latest, most modern type. This Plant, located about ten miles from Baltimore, near the mouth of the Patapsco River, has its own deep water port, served by its own steamships, and includes its own coke ovens, blast furnaces, open hearth furnaces, Bessemer converters, rolling mills, fabricating, tinning, galvanizing and finishing shops. It receives most of its ores by water from the Company's own mines in Chile and Cuba. Its coal comes from the Company's own mines, and limestone from its own quarries.

Starting, therefore, with the raw materials, this plant is entirely self-contained, thus affording opportunity for close supervision of all operations and materials from start to finish. Hence no other Rod and Wire Mill in this country or abroad enjoys more direct or complete service.

The Maryland plant enjoys an advantage in that it is the only large steel plant in the United States located at Tidewater. Its shipping docks are connected by a thirty-five foot channel with the Baltimore-Chesapeake Bay Channel so that it is able to ship its products direct by deep water vessels to both the Atlantic and Pacific seaboards, and also to foreign markets.

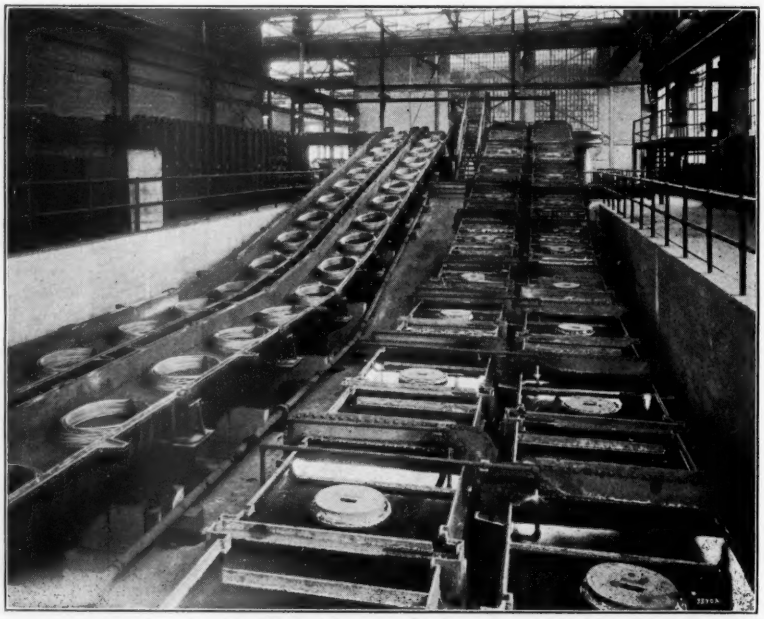
The Maryland plant enjoys two additional advantages of location—it is at the rail as well as the water gateway of the growing industrial district of the South; and it has a large and increasing local market in Baltimore and its environs, which is advantageously served by motor truck delivery.

All those advantages of unusually favorable transportation facilities for assembling raw materials and for shipping finished products, coupled with those derived from the ability to continuously supervise, from raw materials to finished products the grade and character of all material, place this Rod and Wire Plant in a position to most efficiently serve markets for wire products in all parts of the world.

The quantity production of quality rods, wire and wire products demands that the manufacture proceed in orderly sequence, all operations following one another in a simple and direct line. Decreases in excessive handling or travel of materials, substitution of mechanical and manual handling, and up-to-date improvements in all mechanical equipment have a marked effect in improving the efficiency of production.

Recognizing post-war requirements for economical production, careful engineering on this new Wire and Rod mill has provided the best known mill layout and construction. Every conceivable condition and emergency has been anticipated and amply provided for. Manual labor has been reduced to a minimum. Safety features on machines and equipment protect the workmen. Electric power has supplanted steam and has largely eliminated man-power. As far as practicable, individual drives have been installed on machines and units. Spare motor and replacement parts are conveniently available in case of breakdown.

No attempt will be made in this article to describe the preparation of the raw materials and billets used in the Rod and



Open and muffle type bundle conveyors. Sparrows Point plant, Bethlehem Steel Co.

Wire Mill. The various units where these are handled and worked up have been described on other occasions. The general character of the equipment and layout of the Rod and Wire Mill will be touched on, with special mention of some features which represent new and advanced practice. Hence the description of the plant will commence at the reheating furnace where the billets are heated for rolling into wire rod.

Reheating Furnace

This furnace follows the lines of general practice. It is of the continuous heating, side discharge type, recuperative, and with forced draft. Producer gas is used as fuel and the furnace has a billet heating capacity of twenty-five (25) tons of 1¾" square x 30 feet billets per hour. Billets are charged with an electrically operated Charger and Pusher Machine and discharged directly into the first pass of roll train by an electric discharging machine. In mills of earlier design, this discharging was performed manually by means of an iron bar. Accidents were not infrequent, and operations were often slowed down or interrupted. The newer method, employing a 1¾" square steel bar guided by channel guides, performs the operation more satisfactorily.

Gas Producers

Two 10 ft. inside diameter gas producers, each with a coal capacity of 2500 pounds per hour, furnish the gas for the reheating furnace and are housed in a separate building 100 ft. long by 75 feet wide They are automatically charged from overhead storage hoppers, each having a capacity of 26 tons of coal. These in turn are supplied by an electrically operated skip-hoist, which receives coal from a railroad track hopper, dumps it into an overhead chute, which discharges into reciprocating feeders. These feed the coal to electrically operated single roll crushers

General view of rod storage showing hook conveyor at one side.

where it is crushed to size and then discharged into the storage hoppers mentioned above.

The gas produced is carried by a 3'-3" inside diameter feeder from each producer to the main which measures 5'-3" inside diameter and thence to the furnace.

Wire Rod Mill

The building which houses the Wire and Rod Mill has an Aiken type roof, structural steel frame and brick walls, with gypsum roof slabs, floors of concrete and the sash and doors of steel. This building is 350 feet long by 75 feet wide and 30 feet high, and is equipped with a 15 ton capacity crane, 71 feet stand, which travels the entire length of the building. Here is located the Morgan electrically operated two-high continuous Wire Rod Mill, which possesses several outstanding features of technical interest.

Hook Conveyor for wire rods.

This rod mill is different from most others in that it is entirely gear driven. In the past the roll train has usually been driven by means of belts in order to insure the absolutely smooth flow of power required. Gears had a tendency to "jump" the rolls, causing nicks and bumps on the finished rod. In the present mill, however, this difficulty has been satisfactorily overcome by the use of specially cut helical spiral gears driven by a 4000 H. P., 6600 Volt, slip-ring, induction type motor. This design eliminates the uncertainty of belt drive and the loss of power due to slippage by replacement with positive power linkage that assures proper relative speeds of each pair of rolls in the continuous trains.

Another difference is the use of 17 stands in place of the usual sixteen (16). These consist of seven (7) roughing, nine (9) intermediate, and one (1) finishing stand. By the use of the additional roughing stand less work is required in each individual pass, entailing less wear on rolls and bearings, increases ease in retaining the roll draft, and greater production per hour through longer periods of continuous operation and higher speed.

The speed of the first roughing stand is 17.368 R. P. M. or 44.45 ft. per minute. Sixty seconds after entering the first roughing rolls the finished rod emerges from the finishing stand, in which the rolls turn 1195.2 R. P. M. delivering the rod at a speed of 3466 feet per minute.

The rod mill has forced feed lubrication.

Coiling Reels and Muffle Conveyors

Four "Rod Delivery" or "Switch Pipes" and the four coiling reels which they supply are under the control of the man on the platform shown in Fig. — and are electrically operated. Each reel has its own separate conveyor. When the reel is full, guide pins drop

to move onto the conveyor without danger of snarling.

The four conveyors shown in the background of illustration are designed to be of the muffle type and are inclined, the point of delivery being well above the floor line of the mill, for the reason shown hereafter. At the present time two are being used with the muffles and the other two without. The "muffle" type has proven particularly advantageous in the handling of high carbon steels.

At the top of the incline, electrically operated tilting arms receive the bundles of rod and transfer them to the Hook Carrier, as shown in Figure —.

Hook Conveyor

This conveyor is an electrically operated, slow moving cooling rack, 901 feet long, with hooks spaced 4′-3″ centers and set at such a height that, when carried by the hooks, the bundles are about twenty (20)

Interior of the rod cleaning house shows bundles of rods being transferred to pickling baths.

inches from the floor. Forty-two (42) minutes are required for the bundles to travel the entire circumference back to the discharge point where they arrive at room temperature. Here the bundles are lifted from the hooks, laid upon the rod trucks in lots of eight bundles to the truck, and delivered to the Shipping Platform for loading on railroad cars; or to the Rod Storage Building whence they are taken to the Rod Cleaning and Baking Department.

Rod Storage Building

The rod storage building has a structural steel frame, with brick walls on concrete foundation, provided with steel sash and doors. It has an Aiken type roof and a wood block floor on concrete. The building is 150 feet long by 75 feet wide and 33 feet high, has a storage capacity of 1000 tons of rod, and is provided with 200 rod buggies. Rods are handled in this house with an overhead crane and a depressed track is provided at one end for loading trucks.

General view of No. 1 rod mill showing heating furnace in background.

Rod Cleaning and Baking House

Housed in a building 175 feet long by 100 feet wide, is the Rod Cleaning and Baking Department, where the rods are cleaned, pickled, water coated; or limed and baked, depending upon the requirements. Downey Type yokes, made of acid resisting bronze, are used for carrying the bundles of rods to the various operations.

Ten wooden pickling tubs, each having a capacity of 850 gallons of pickling solution, are arranged in a semi-circle. Acid can be run directly into these tanks from individual acid tanks, which are graduated in gallons. One oval type wooden tub of the same design as the acid tubs is provided for rinsing the rod after pickling. There are two lime tubs made of steel plate.

A steam operated jib crane with a boom of twenty foot (20 ft.) radius serves the Acid Pickling and Water Rinsing Tubs which, as mentioned above, are arranged in a semi-circle so that the hoisting hook of the crane will revolve over the center of each tub. Another similar crane, but with a boom of 14 ft. radius, is arranged to serve the Water Rinsing and Lime Tubs.

Shipping platform 12 feet wide and 1525 feet long.

Rod that is to be "water-coated" or "rusted" is handled in a Rust Conveyor 8′-0″ wide by 40″-0′ long, of the chain type. This conveyor is mounted on a wooden frame, is electrically driven, and equipped over the entire length with spray nozzles. It is built to accommodate the Downey Type yokes, and there is a return yoke conveyor which returns the empty yokes to the first acid tub for reloading.

Sulphuric acid for pickling is stored in two steel tanks, each of 10,000 gallons capacity, located outside the building on steel towers at an elevation of about 32 feet above the general level. The acid flows by gravity from these tanks to the individual acid tanks in the Rod Cleaning House.

A separate brick building is provided for lime. Here the lime is slaked and stored in two bins, each of two thousand cubic feet capacity.

The baking equipment consists of a ten track wire rod baker, each track capable of holding eight truck loads of bundles of rod. The Baker is divided into five sections, each section containing two tracks 62 feet long. Separate heating by fuel oil or bituminous coal is provided in each section, with unit control for cutting out any one or more of the five sections. Each compartment is closed on

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The Galvanization of Iron and Steel Wire*

By Dr. H. Altpeter

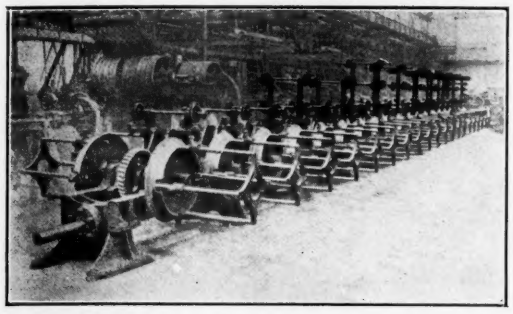


Fig. 3—Spooling machine for galvanized wire which facilitates easy removal of coils.

IRON and steel wire loses under air pressure its bright, glistening appearance and turns dull. It is for this reason that one covers such wire with metal-coatings. The various coatings serve various purposes. Coppering and nickel-plating e. g. lends to the wire a bright, colorful appearance, while zincing and tinning protects it more or less against rusting. There is, however, a third process, the so called "high-polish-zincing," that meets both ends.

Coppered wire — which we shall not treat in detail—has a bright-red, lustrous color, and in case of proper performance of the process can not be distinguished from copper-wire itself. One often uses such wire for the manufacture of spiral springs and also for other wire ware to which one wants to lend an impressive appearance. We do not have to consider electro-coppering as it is seldom applied to wire. Electro-coppering and electro-zincing are homologous processes. The pickling of the wire, the arrangement of the troughs, anodes, and reels is the same and will be illustrated under electro-zincing.

ZINCING

The best known and most frequently used rust-protective coating for iron wire is probably zinc. Zinc has a bluish-white color and a specific gravity varying from 6.5 to 7.1 according to its state of aggregation. It melts at approximately 420 degrees C and vaporizes at about 700 degrees C with a white light. Zinc coatings are bright or dull according to the process and vary as to their adhesion.

One distinguishes two fundamentally different processes: hot-zincing and galvanic or electro-zincing. The former is based upon the phenomenon that iron of chemically pure surface if dipped into liquid zinc, that is at a temperature of 450 C, is being covered with a coat of zinc. Electro-zincing or galvanization is performed under normal temperature and is based upon an electrolytical process. Zinc —as anode—is diluted under the influence of intense current, and the wire—as cathode—passes slowly through the bath. The zinc settles on the wire without forming in intermediate alloy-zone. Considering the elimination of intermediate alloy layers, galvanization should be preferred to hot-zincing as chemically pure zinc is but slightly soluble in diluted acids thus assuring an almost weather-proof coating. Perfectly pure galvanic coatings can not be obtained either. Experience shows that even galvanization disengages a certain percentage of metals and non-metals. Hence, galvanization and hot-zincing have many characteristics in common. The latter process, however, does not only disengage zinc and ferriferous zinc-alloy but also lead. The commonly traded and used zinc contains on the average 98% pure zinc and approximately 2% other metallic admixtures as can be seen from the following table:

Both re-melted and distilled crude zinc are used for zincing purposes. The quality of a zinc coat is determined by its power of resistance against salts and acids. This resistance decreases in proportion to the decreasing thickness of the wire. The thinner the wire the more zinc drips off when it leaves the bath as such wire is more intensely heated while in the bath. The rating method for zinced wire is also based upon this power of resistance. The rating-test runs as follows: the wire is dipped into sulphate of zinc and remains there for one minute, the dippings are repeated until the wire shows a spotless copper surface, and the number of dippings necessary serves as a

TABLE I.

	Lead %	Iron %	Cadmium %	Zinc %
Upperbank (England)	2.55	0.15	0.09	0.05
V. M. G. (Belgium)	0.66	0.25	.....	0.03
Vieille Montagne (Belgium)	2.00	0.14	0.07	.....
Freiburg (Saxony)	1.03	0.04	0.02	0.07
Lazyhutte (Upper Silesia)	1.124	0.024	0.017	.....
Lipine, Elektrolyt, (Up. Sil.)	0.06	0.01	0.005	0.02

*Translated from Stahl u. Eisen.

measure of the resisting power of the zinc coating. The sulfuric-acid test measures the time required for the evolution of hydrogen gas and rates the quality of the coating accordingly. The German Postmaster General e.g. endorses for the former test a solution containing 20% sulphate of zinc which has to be applied under a temperature of 15 degrees C, and specifies the number of dippings according to the thickness of the wire.

The resisting power of the coating against peeling is measured by winding the zinced wire around spools of various diameters. The German Post Office specifies spools of ten times the diameter of telegraph wire for the best test of the latter. The tested wire is not acceptable if it shows cracks nor if it turns brittle. The application of this test regulates automatically the thickness of the zinc coating as very thick coats scale very easily.

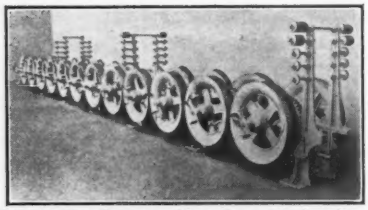
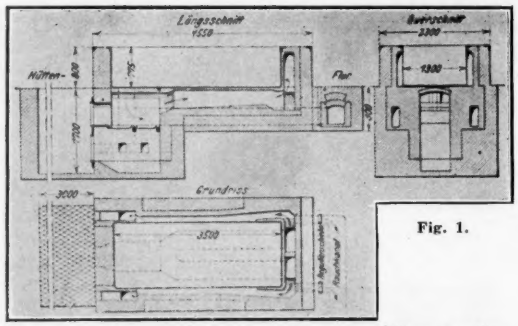


Fig. 2—Spooling machine for zinced wire built by Malmedie & Co.

The thickness of galvanic coatings depends upon the duration of the process. It too is limited by the fact that too thickly galvanized wire becomes brittle. There is a misconception current among laymen that galvanization is a perfect protection against rust. Galvanization, however protects the wire only for a certain period of time. The influence of atmospheric elements and the constant presence of sulphurous and carbonic acids in the air cause, sooner or later, the decomposition of the zinc coating. This decomposition is an electrolytical process. The moisture between zinc and iron results in the formation of a galvanic element with the zinc acting as dissolving electrode. Hence, galvanization is only as long a rust-protective for iron as the latter is covered with undiluted zinc. Buyers of zinced wire ware often complain of rust on wire-nettings and trenches as the frequent cutting of these two items exposes the bare iron to wind and weather thus hastening the process of decomposition.



Imbedded zincing tub
1) longitudinal section. 2) cross section. 3) horizontal section.

Fig. 1.

Hot Zincing

The procedure is as follows: the wire is pickled, passed through a heated tub containing liquid zinc, run through a skimming apparatus, and is spooled upon a reel. One commonly uses a solution of hydrochloric acid (15 to 20%) for pickling ingot wire, although sulfuric acid may be used too. Steel wire requires an exceptionally careful treatment on account of its sensitiveness with respect to acids and has to be pickled in a very weak solution of hydrochloric acid. It is advisable to dip it, in addition to this treatment, in a bath of zinc-chloride and water in order to assure firm adherence of the coating. The pickling usually is done in stone vessels or in wooden lead-plated tubs. The used acids have to be arsenic-free as the latter chemical causes black spots on the wire. Warming of the bath accelerates the pickling process and is applied to rolled wire and sometimes even to annealed and wet-drawn wire according to the thickness of the scale. The pickling usually is extended over a period of fifteen minutes. In the case of thinner wire, however, proportionally less. Wire which has been drawn in grease has to be cleaned in hot soda lye or hot soda solution before the pickling process can take place.

The pickled wire is spooled upon rotating reels and runs over transportation rollers into the zinc bath. It is introduced into the bath and guided underneath horizontal bars or forged rods until it reaches the end of the tub. Upon leaving the zinc bath it is directed through a so called "skimming apparatus" or an asbestos-lined press and spooled upon a reel. The second roll of wire is simply knotted to the first one. The opening of the skimming apparatus therefore has to be wide enough to permit the wire-knots to pass through. The lining of the skimming device has to be replaced whenever a new spool is drawn through the bath. Figure 1 illustrates an imbedded zincing tub. Such tubs or troughs usually are the oblong shape and vary from 4 to 20 cubic meters in capacity according to thickness and quantity of wire that

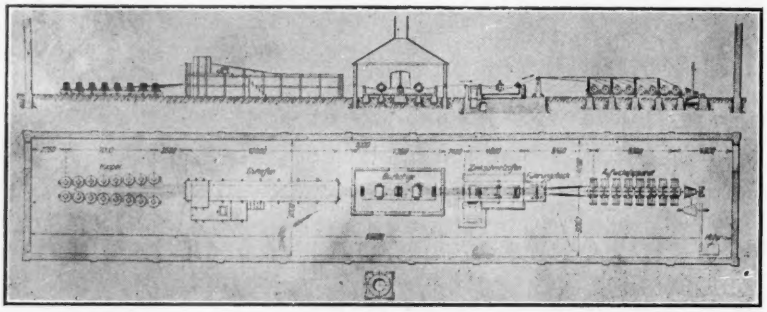


Fig. 4—Hot zincing plant for 16 wires.

is to be zinced. It should be remembered that great quantities of liquid zinc are excellent heat accumulators which counterbalance the effect of the cold wire, thus keeping the fluctuation of temperatures in check. The welded sheet iron of the zincing tubs is from 15 to 30mm thick according to the capacity of the tub. The upper edge of

Fig. 5—Ferruginous zinc alloy with imbedded zinc crystals.

the tub is reinforced so as to assure firm support of the skimming apparatus and of the dipping hoop. Cast iron is too porous a material to serve for the construction of zincing tubs. One dips approximately 50 wires at the same time. The size of the tub has to be adequate to the volume of wire in order to avoid heat loss. Only the central sections of the side walls and the bottom are heated, while the remaining parts are firmly imbedded in firebrick. This arrangement of the heating system minimizes the formation of ferruginous-zinc-alloy which is formed whenever the melting walls of the tub combine with the liquid zinc. We shall treat later of this formation of ferruginous-zinc-alloy.

It used to be customary (see figure 1) to heat the lower parts of the side walls and then the bottom, sometimes even first the bottom and then the side walls. Today, however, the procedure is reversed. One first heats the upper parts of the side walls, while one leaves the bottom at normal temperature until the side walls have been thoroughly heated (see figure 6). This method reduces zinc-alloy to a minimum, assures the formation of ferruginous-a more uniform heat-penetration of the upper parts of the bath which are strongly affected by the cold-dipped wire, and facilitates furthermore proper warming of frozen baths. Heating from the bottom causes the lower stratum to expand, tear the welded seams, and result in leakage of the tub. The heat formerly was supplied by coal-combustion on plane or sloping grates (see figure 1). More recent developments, however, favor generator-furnaces, hydrogen gas burners, and liquid fuels, such as tar-oil and the remains of petroleum. The coal consumption of plane grates ranges from 7 to 10% of the weight of the zinced ware, the use of generator furnaces or gas heating systems, however, reduces it to approximately 5 per cent. Oil heating systems produce somewhat similar results and are employed whenever local conditions permit it.

The depth of immersion of the wire is regulated by lowering and raising of the guide-bars. Some firms employ for this purpose forged iron bars. This lowering or raising of the guide-bars regulates automatically the duration of the dippings. The bars are lowered whenever the thickness of the wire necessitates intense dipping, while thin and light wire is just dipped in the center of the tub thus assuring minimum duration of the dipping process and relatively little heating. The skimming apparatus at the end of the tub consists either of a forged iron bar or of a frame which supports as may screw presses as wires under treatment. The former is lined with asbestos-cord and the latter are lined with asbestos-plates. Asbestos-cord is used whenever a comparatively thick and rust-proof coat is the primary requirement, while the use of asbestos-plates lends to the wire a bright-lustrous, silver-white appearance.

The so-called "sand-zincing-process" provides still another way for the removal of the superfluous zinc. The procedure is as follows: a thick layer (100-120mm) of sharp-edged, wet river-sand is placed upon the liquid zinc. The wire runs as usual through the bath but passes before leaving the tub through this sand which effects but a slight skimming. This method is applied whenever rust-protection is the deciding factor. Sand-zincing requires a very slow speed of the wire which should emerge in vertical position so as to assure even coatings.

The zinced wire is spooled upon single or so called combination-reels, the latter facilitating the spooling of 24, sometimes even 50 wires at the same time. One usually uses windlasses with horizontal spools for heavy wire and vertical spools for light wire. The drums of the latter are of sheet-iron and are operated by means of a friction-clutch. Figure 2 shows a spooling machine for light and medium wire. The two-part folding drums run upon a worm-gear driven axle the velocity of which can be regulated by means of a conical speed-pulley. The wire runs over guide-rollers before it is spooled. These guide-

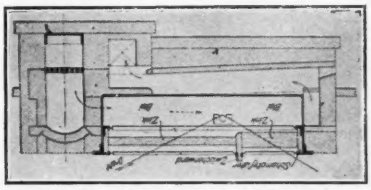


Fig. 6—Zincing bath with lead filling to reduce the formation of iron-zinc alloy.

rollers are attached to a movable arm which shifts from the left to the right, thus facilitating even spooling. Spooling-machines with horizontal drums which are based upon the same principle as the customary drawing-benches (see figure 3) are also used. These spools provide for just one layer of wire, a fact which makes later classification and division comparatively easy. The speed of these machines can also be adjusted to the velocity of the wire in the bath. The drums for 1.6mm wire measure up to 600mm in diameter, while the drums for lighter wire vary between 200 to 300mm. Drums for heavy telegraph wire, which is dipped

(*Continued on page 248*)

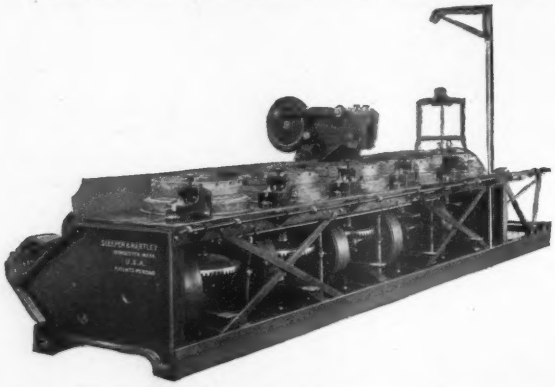
Sleeper & Hartley
TRADE MARK

Practical Continuous Vire

These Machines Go Into Production at ice—

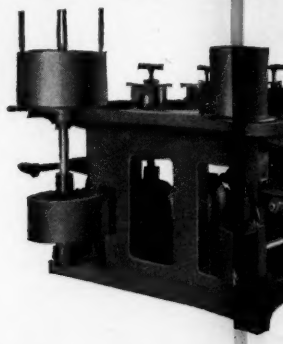
Rod Frame

(No. 5—14 or 15 wire)
Patented June 3, 1924—May 12, 1925—others pending
All Ball or Roller Bearings
No Differential Gearing.
Automatic Compensation for Speeds of Heads.



Double 5-Draft Dry,

No. 14 to No. 23, gh or
3 to 4 Blocks Avera
No. 14 to 19—4 le, 140
No. 14 to 20—5 le, 110
More than 250 heads of this prove



Spring Coiling Machinery

of every description.

For example, we offer:

Universal Spring Coiling Machines

in ELEVEN Sizes

handling oil-tempered wire from .004" to ⅝" diam. These machines produce spring forms as illustrated herewith at very high productive speeds.

Patented

AGENTS: CHICAGO TERRITORY,
Neff, Kohlbusch & Bissell, Inc.

SLEEPER & HA

FOREIGN AGENTS AND REPRESENTATIVES: UNITED KINGDOM—Mr. Fredk. A. Perry, 63 Queen Victoria St., London, E. C. 4. FRANCE—Mr. Edgar Bloxham, 12 Rue du Delta, Paris. BELGIUM—Isbecque, Todd & Cie., 25-27 Boul. Emile Bockstael, Brussels.

WORCESTE M

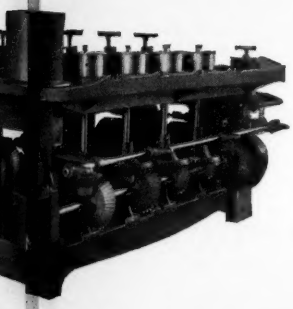
Wire Drawing Machinery

Sleeper & Hartley TRADE MARK

at ice—Reducing Overhead-Increasing Production!!

af Dry, Intermediate

23. gh or low carbon wire.
cks Average Operator.
–4 le. 1400 lbs. per block.
–5 le. 1100 lbs. per block.
f thi proved model in operation

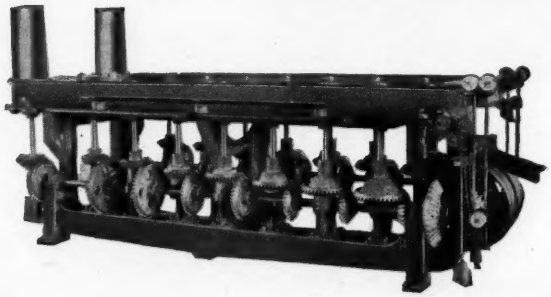


Double 8-Draft Fine Wire: Wet

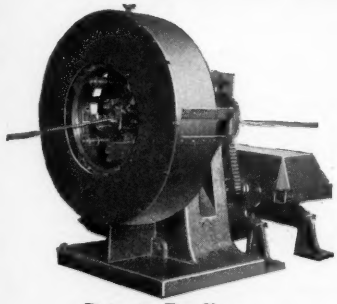
No. 22 to 36. High or low carbon wire.

6 Blocks to Average Operator, 22-33, 8-hole, 660 lbs. per day of ten hours.

Many thousands of these heads in operation



ARMORING MACHINES FOR "BX," PARK CABLE MOTOR WIRES, HOSE Etc., Etc.



Patents Pending

High Productive Speeds

LOCK WASHER MACHINERY

with Enormous Output

HIGH SPEED STRANDING MACHINERY

tHARTLEY, Inc.

Agents: Philadelphia Territory
Swind Machinery Co.

ITALY—Henry Coe & Clerici, Milan. AUSTRALIA AND NEW ZEALAND—Edwin Wood Pty., Ltd., Melbourne. JAPAN—Andrews & George Co., Tokyo. SWEDEN AND FINLAND—Akt., Rylander & Asplunds, Stockholm.

C MASS., U. S. A.

Foreign Trade in Wire Declines

Strong German and Belgian competition in Central and South America

AMONG six large classifications of iron and steel products wire and wire products alone failed to gain in exports from 1925 to 1926. This failure to gain—or even retain—its position in the world's export markets may be attributed to the strong efforts being put forth by German and Belgian wire manufacturers to more firmly establish themselves in the markets of Central and South America.

It is probable that the American export trade in wire and wire products was more strongly affected by competition from European manufacturers than any other similar group of products—at least the 1926 trade in wire and wire products is the only trade to show a decrease when compared with the statistics of the trade of 1925. There were, in 1926, 98,517 tons of these goods exported as compared with shipments totaling 122,008 tons made in 1925—a decrease of 23,491 tons or 19.2 per cent. It must be noted, however, that this decrease was by no means general throughout the eight products combining to make these totals—exports of galvanized, plain, and barbed wire only showed decreases, shipments of bright wire and wire cloth and screening remained virtually the same, while those of woven-wire fencing, wire rope, insulated steel wire and cable, and the commodities included in the group "other wire and manufactures of" all increased to some amount.

Barbed wire, with total shipments of 46,563 tons, was the principal commodity in this trade, bright wire, with 17,131 tons, being second, and galvanized wire, 14,180 tons, third. The tonnage of the shipments of the other products included in this classification were wire rope, 4,779 tons; woven-wire fencing, 4,155 tons; wire cloth and screening, 1,989 tons; insulated steel wire and cable, 738 tons; and "other wire and manufactures of," 8,982 tons.

Canada was the principal market in 1926 for American wire, taking in all 21,498 tons of these goods, 7,287 tons out of the total being galvanized wire, 5,127 tons being barbed wire, and 4,551 tons being bright wire. In the trade with Mexico, 20,581 tons, 5,541 tons of barbed wire constituted the principal purchase and 3,634 tons of bright wire the second largest. Brazil, with a total of 8,030 tons was

(*Continued on page 245*)

Imports of Iron and Steel Wire and Wire Products Into the United States

[In gross tons]

Item	March, 1927	April, 1927	January through April	
			1927	1926
Wire rods	1,466	707	4,614	3,444
Barbed wire	584	328	2,210	1,884
Round iron and steel wire	233	456	1,279	1,439
Steel telegraph and telephone wire	.....	1	25	82
Flat wire and strip steel	252	277	938	967
Wire rope and strand	245	361	925	610
Other wire	66	98	203	683
Nails, tacks, and staples	209	532	1,788	862
Bolts, nuts, rivets, and washers	14	13	86	206

(Compare Tables on pp. 246-247)

Sources of Imports of Iron and Steel Wire and Wire Products Into British Malaya in 1925 and 1926

[In gross tons]

Item	Total		United States		United Kingdom	
	1925	1926	1925	1926	1925	1926
Wire fencing	2,705	3,211	313	100	189	139
Electric wire, uninsulated	11	13	.....	.....	11	12
Other wire	2,381	4,092	4	1	982	1 090
Wire cable and rope	563	865	43	55	462	759
Wire netting	348	670	1	1	200	226
Wire nails and staples	5,015	6,868	7	5	306	475
Other wire manufactures	109	98	3	2	68	83
Nails, tacks, rivets, and washers	865	1,102	141	42	570	620
Screws, bolts, and nuts	1,051	1,408	40	54	712	736
Chain	191	261	6	.....	160	197

Exports of Copper Wire

IN April, 1927, the export of bare copper wire amounted to 845,814 pounds ($139,406) as compared with 1,307,763 pounds ($230,127) in April, 1926. During the same periods the exports of insulated copper wire and cable were 1,887,425 pounds ($461,543) and 2,088,044 pounds ($532,376) respectively.

Wire Companies Win Prizes for Industrial Advertising

IT is interesting to note the development of advertising technique on the part of wire manufacturers. At the recent National Industrial Advertising Association convention, held at Hotel Statler, Cleveland, June 13 to 15 two wire companies were awarded prizes for their advertising exhibits. The Rome Wire Co., Rome, N. Y. won the second prize for the best business paper advertisement, while the Atlantic Insulated Wire and Cable Co., Rome, N. Y. was given second prize for the best institutional advertising.

Woven Wire Netting

Details of manufacturing process—Large growing industry—Foreign competition.

By M. A. Hall

WOVEN wire netting, or as it is usually called wire cloth, is an off-shoot of the wire industry inasmuch as its raw material consists of wire, while its finished product still carries the adjective wire. Since metal wire is not as flexible as yarns, the machinery used in weaving textiles can not be used. As will be pointed out hereafter, however, the principle followed is largely similar.

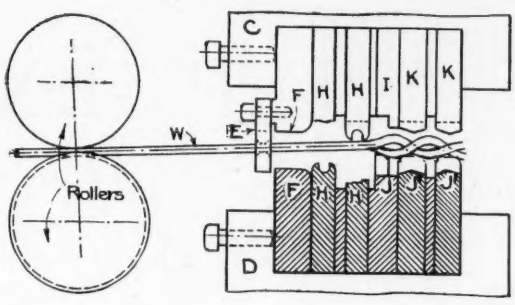


Fig. 1—Diagrammatic sketch of James wire weaving press as used for making wire netting. This indicates how parts of the die form loops in the wire for introduction of the cross wires of weft, the length wires or warp W feeding in from the left and the finished metal fabric issuing from the press at the right.

That this manufacture amounts to a considerable business may be noted in the census figures, which show a value for woven wire and netting production of $37,364,000 in 1923, a considerable increase over the $24,642,000 of 1921. This indicates a decrease in unit price, for the production in 1921 was 242,000 tons, which had increased to 413,000 tons in 1923. In the latter year, exports totalled 1,960 tons, valued at $851,000. The increase of foreign competition in more recent years has cut the export totals as well as the unit price.

Within this business, practically each large firm has its own machinery, developed and perfected by it through its own experience. Much of this is held secret, the various firms believing that such secrecy is necessary. The following process is known as the James, after the inventor and developer of the machinery described and illustrated.

In general reference is had to the use of 3/16-in. wire woven so as to be 3/4 in. center to center in the finished cloth, but that is simply a matter of construction and regulation of the various dies and determining units of the machines, which will weave any size of wire and any desired fineness (or coarseness) of cloth. Wire cloth is now woven in this country for commercial purposes from 4 mesh (slightly closer than mentioned above) down to 350 mesh. In addition, special and extra fine mesh cloth is woven for laboratory and other unusual purposes down below 1,000 mesh, but within the scope of this article and the machinery described is not considered as "commercial" being special in all respects.

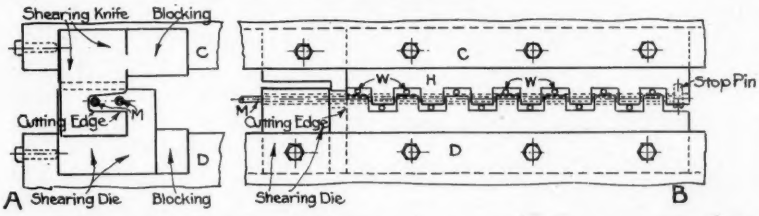


Fig. 2—A at Left shows opening above the cutting edge where the cross wires are inserted and edge which cuts them to the proper length on the up stroke. They are inserted long and cut to exact width rather than cut to near-width and inserted as such. B at Right shows longitudinal section across the press with straight wires at W, cross wires at M, stop for latter at the right and cutter at left. This shows also how the 'net' is formed by the interweaving of the wires.

In this James process, the cloth is woven in a special press, so-called because it approximates press construction more closely than that of any other ordinary machine. It consists of a bed or base D, in which dies are assembled and a movable ram C, which is propelled up and down through a cam and roller movement and aided by strong springs.

At the end of the up and down strokes, cessation of motion is necessary to permit insertion of the cross wires, equivalent to the woof of weft of textiles. This temporary stopping is accomplished by a long flat cam, which operates between the two driving rollers. The lower roller runs in bearings on the sliding head of ram (C), while the upper is journalled in the yokes. Strong springs take up the slack and keep cam rollers in constant and intimate contact.

Referring to Fig. 1, the ram C is in its lowest position. This shows the grouped dies in both bed and ram, also the wire being fed in from the feed rollers at the left and the formation of the wire netting within the machine. The dies marked H are for looping and are each made with grooved ends which loop the length wires W, as they come into the machine from the

WIRE SPOOLING and WINDING EQUIPMENT

Full information on request

CHAS. KOEGEL & SONS CO.

Holyoke, Mass.

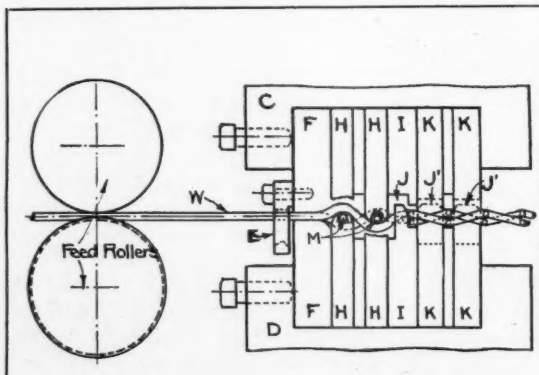


Fig. 3—The James press at the end of the up stroke, showing how the partly woven netting is freed from both upper and lower dies and stands midway between the two. This is just previous to the squeezing or crimping operation which flattens the loops and makes the whole fabric flatter and thinner.

feed rolls, alternately up and down so as to form a shed.

These H dies have a rounded groove in their ends which form a passage across the machine, through which the cross wires (to form the weft) are fed. By inserting these wires in these places, the cross wires are also positioned between the sheds of the loops, thus accomplishing the weaving. These cross wires are in cut lengths but longer than actually needed for the width of cloth being woven and not neccessarily cut with great

accuracy. Consequently, the machine, as will be explained later, is so arranged as to cut off the cross wires to the exact width of the metal fabric being woven, as a part of the process. As a simple, every-day, practical detail it has proven more economical to manage this in this way than to feed in exact lengths.

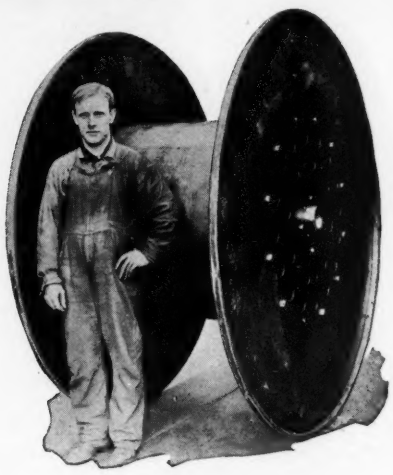
The dies are shown closed in Fig. 2B. This shows also the looping of the length wires W, with the cross wires M inserted. In addition, it shows the shearing knife and die which do the work of cutting the cross wires previously referred to. The cross wires, before going through the grooves in the looping dies, pass through holes in the shearing die and over the cutting edge of the shearing knife. When the ram rises, the shearing knife cuts off the cross wires from the longer lengths and at the face of the holes. This latter face thus determines the width of the metal fabric.

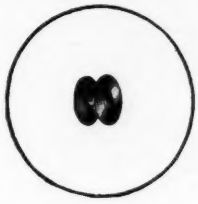
The shearing knife is open on one side so the wires M after they are sheared off and woven in, can be moved back through the machine along with the length wires when moved forward by the feed rollers. The face of the shearing arrangement is shown in Fig. 2A, the openings through the face of the shear knife being shown as well as the upward-working cutting edge.

The wire spacer and lift bar extends across the front of the dies. It has a number of oblong openings, arranged vertically, and spaced throughout its length to suit the material being woven. Through these the length wires pass on their way to the feed rollers. The function of the former is to keep the length wires equally spaced as well as to free the wires from the dies after being woven, so it can be moved on through the mesh. As the ram rises, the lift bar E rises also, but the wires do not on account of the vertical length of the holes, until the plunger has risen half of the stroke. This arrangement permits the top dies to free themselves from the wire.

During the remainder of the

AMERICAN
PRESSED STEEL
REELS





2½ INCHES *or* 8 FEET

"AMERICAN" Pressed Steel Reels and Spools are practically indestructible. More easily handled because they are *balanced.* Stronger and more rigid because of their unique design of pressed steel. *Always true to gauge* as specified — they are made with the same precise, honest workmanship as are "American" Belt Pulleys and Shaft Hangers.

The American Pulley Company

Manufacturers of Steel Split Transmission Pulleys, Pressed Steel Shaft Hangers, Pressed Steel Hand Trucks and Pressed Steel Shapes

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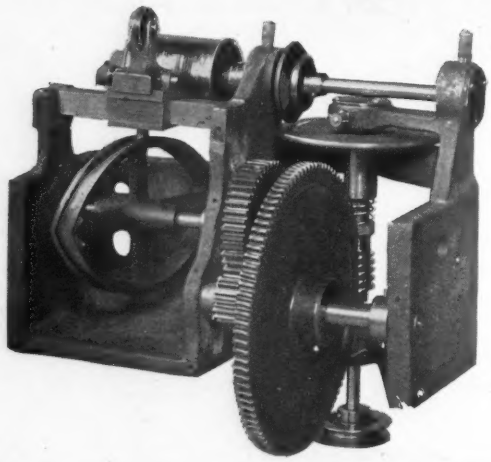
WHATEVER your requirements for handling your product during all the processes of manufacture—annealing, braiding, stranding, vulcanizing, impregnating, or for shipping—"American" Pressed Steel Reel or Spool will do the job better and remain on it longer.

Made in standard types from 2½ inches in diameter to 8 feet. Special Reels or Spools to your specifications. Write for catalog.

Spooling Attachment

Spools wire from .018 to .003 **Dimensions 12″x12″x15″**
Weight Approximately 50 lbs. **Ball bearing equipped**



The above illustration shows an open view of our No. 1 Spooler. All gears are enclosed.

Uniform tension and lay of the wire on the Spool is assured by the use of a screw cam. It is inexpensive, simple to operate and can quickly be attached to any machine.

CYRUS CURRIER & SONS

365 Market St. **NEWARK, N. J.**

Olsen Vertical Autographic Pendulum Type
WIRE TESTER

Made in capacities from 50 lbs. to 1000 lbs.

This illustration is of the very latest up-to-date Autographic Wire Tester which will scribe the stress strain diagram on square cross-section paper, correcting for the sine angle of the pendulum to magnify the elongation of the wire ten times. The autographic record may be taken directly from the wire, and thus the greatest of accuracy secured in such a record, as we do not consider any autographic record or wire test as satisfactory or acceptable taken from the motion of the heads of the testing machine.

Olsen Autographic Wire Testers can also be secured of capacities from 10,000 lbs. up to 1,000,000 lbs. capacity for testing steel, copper or brass wire of all gauges, as well as the largest wire rope made.

Also manufacturers of Olsen Static-Dynamic Balancing Machine equipment for balancing high speed rotating parts, which will eliminate vibration and increase efficiency and production of all high speed machinery.

Manufactured by

TINIUS OLSEN TESTING MACHINE CO.

500 North 12th St., Philadelphia, Pa.

upstroke of the ram, the length wires have come into contact with the bottoms of the oblong openings and as the bar continues to rise, this lifts the wire free of the bottom dies also, thus centering it between the two as shown in Fig. 3, when it is moved forward by the rollers.

These rollers are far enough away so that when the lift bar E raises the length wires it will only spring them, and not put a permanent set in them.

The bar marked J in Fig. 3 is the spacing bar. It has equidistant notches to receive the wires W and keep them in correct lateral position. It runs the length of the dies (or width of the cloth), with projecting ends formed with beveled notches so as to catch the length wires as they descend from the ram and center them where they are locked by the tightening dies K. These depress the length wires down on the cross wires and crimp the latter, also put a more perfect crimp in the length wires, thus locking both with one another.

The spacing blades J′, set in the tightening dies K to center the cross wires, serve these as the spacing bar does the length wires. The feed rollers are intermittently rotated when the dies are opened, bringing forward another portion of wire for the dies to operate on; the wires all coming on the same horizontal plane. Then the ram descends with the lift bar and the wires on meeting the spacing bars J and J′ are centered over the dies, where they are acted upon by those dies, the wire being crimped with two more cross wires fed in. The ram rises, shearing off the cross wires, the lift bar again centering the work to be moved by the feel rollers for another operation.

The mechanism for these rollers is not shown but the rollers receive motion from the end of the power shaft by a cam and ratchet movement.

The tightening dies (Fig. 3) have a surplus of wire to deal with. The looping dies need more wire to make the loops so

(*Continued on page 248*)

Hard Drawn Copper

Its Mechanical Properties—Useful Data

THE characteristics of copper which has been subjected to cold work have formed the basis of several extensive researches. It is known that the hardness of the metal increases as the diameter decreases, but the relationship between these functions has been very variously described. As a result of this, specifications covering supplies of material were widely different until the British Engineering Standards Association formed a Committee to produce sufficient standard specifications to govern the whole of the material for conductor purposes. This work, so far as copper is concerned, is now completed, there being four standard specifications for copper conductors.

Naturally, the standardization of a value for resistivity is of first importance. The B. E. S. A. value is that prescribed by the International Electrotechnical Commission, so falling into line with all countries actively engaged in production of conductors. This resistivity value, in its most practical form, is expressed in B.S.S. No. 7—"Annealed Conductors for Light and Power"—in the following manner:—

"The resistance of a solid conductor of standard annealed copper at 60 deg. F., 1,000 yd. in length, and of a uniform cross-sectional area of one square inch, is 0·0240079 ohm."

This is qualified by a statement that the co-efficient for the variation of resistance with temperature is 0.0022221 per deg. F. For hard-drawn wires, where the resistance is known to increase directly with the hardness, the amount of increase permitted is covered by the expression $P=\frac{T}{10}$, P is

A SCOTT TESTER

For Wire, Sheet Metals and Other Materials

A simple, practical recording tensile testing machine

Maximum Capacity 2000 lbs.

The test results are automatically recorded on standard letter size forms (8½x11 in.) The machine is easily handled; is safe and strong and free from delicate parts. Does not require a trained operator or technical man.

Manufactured By

Henry L. Scott Co.

101 Blackstone St., Providence, R. I.

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All Tools for Wire Working Machines

HIGH SPEED

CHAIN LINK FENCE MACHINES
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FOUR SLIDES
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Specialists In Wire Working Machinery

LAVITE is the BEST Annealing Equipment Investment

Here is a record on wire annealing:

The former cost on high grade alloy wire was $12.00 to $22.00 per unit charge. This cost was reduced in the **Lavite Annealing** to $4.30 and better wire obtained.

Here is another record:

The cost of annealing and cleaning low carbon wire under continuous production conditions was $4.60 per ton. This was reduced by **Lavite Annealing** to $2.70.

LAVITE is the BEST HEATING MEDIUM.

No other method of heating gives perfect heat transference, uniformity, and neutrality to metals. Because of its peculiar properties, Lavite can be used thru a range of 1000 degrees without any change or deterioration. It is the only heating medium which is neutral to metals thru this wide temperature range.

Can you afford not to invest in a Lavite installation?

Write for details on your annealing proposition.

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Metal Spools For Wire Drawing

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Hubbard Spool Co.

1622 Carroll Avenue

Chicago

the resistivity increase per cent. T the tensile strength in tons per sq. in. The tensile test is without doubt the most accurate method of ascertaining the amount of work that has been given to the wire. Whilst some investigators claim that the relationship is more complex, it is found that a series of tests on various sizes of wire give an expression that is very closely a straight line curve. Although B.E.S.A. give no hint of this in their tables of permissible minimum tensile strengths, the values given in the Tables have been carefully analyzed, and show very small deviation from such an expression. For the assistance of those who wish to interpolate sizes not specifically covered by the B.E.S.A. the following are the expressions derived from the various specifications.

B.S.S. 125 (H. D. Transmission Line Materials.)

Above 0:215 in. dia.

$$T = 30.92 - 20.78D$$

Below 0:215 in. dia.

$$T = 31.31 - 23.76D$$

B.S.S. 174 (Telephone and Telegraph Line Material.)

$$T = 31.37 - 19.51D$$

Municipal Tramways Association (Round Trolley Wire.)

$$T = 27.61 - 10.00D$$

Municipal Tramways Association (Round Trolley Wire.)

$$T = 26.61 - 10.00D.$$

The tensile strength of soft wire varies from 14 to 16 tons per sq. in., whilst a cast wire bar gives but 8 tons per sq. in. The elongation of a soft wire is about 45 per cent. on a length of 10. in., but this value also is dependent on the wire diameter. In the hard state, at 0.4 in. diameter, 3 per cent. is a frequently prescribed minimum value, but at 0.1 in diameter, 1 per cent only is obtained. Annealed wire has a yield point at 30 per cent of its ultimate load, but this is increased by drawing to 75 per cent. The value of Young's modulus varies from 11 by 10^6 lb. per sq. in. in the soft wire, to 18 by 10^6 lb. per sq. in. in fully hard wire. On the Brinell scale, the hardness number for soft copper is 45, and for hard, 95. Scleroscope

values, with the special magnifier hammer, are 11 and 50.

The data given in this article have been supplied by Messrs. British Insulated Cables, Ltd., whose wire mills at Prescot, are amongst the most important in this country.

Reprinted from The Electrician.

Foreign Trade in Wire Declines

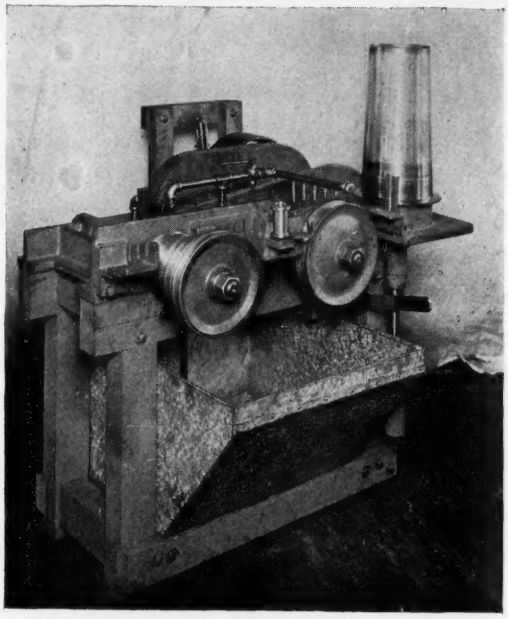
(*Continued from page 238*)

third—better than three-quarters of the shipments being barbed wire. The greater part of the Colombian purchases (7,430 tons in all) was also barbed wire, and this same product predominated in the 5,541-ton trade with Cuba.

Other markets which purchased appreciable quantities of American-made wire or wire products were the Philippine Islands, 5,297 tons, mostly barbed wire; Argentina, 5,217 tons, in which trade the sale of bright and barbed wire were of about equal tonnage; Australia, 4,043 tons, in which bright wire predominated, as it did in the case of the United Kingdom, 3,166 tons; and Venezuela, 2,769 tons, of which quantity three-quarters was barbed wire.

MR. Earle D. Hargraves, Miller Ave., South San Francisco, formerly affiliated with the American Steel & Wire Co.'s plant in Worcester, Mass., has, with the aid of co-workers, formed the Specialty Wire Co. at So. San Francisco, Cal. The business of this newly formed company will be conducted in a new one-story building which is to be constructed by R. C. Stickle, 304 Linden St., which with the equipment, will cost about $50,000. The additional acres of land have also been purchased for future use. The officers are as follows: Mr. Hargraves, Manager, and Mr. Martin L. Spangler, an official. The latter was previously with the Edwards Wire Works, South San Francisco.

The "Superior" Wire Drawing Machine



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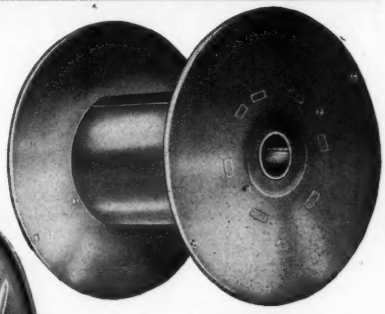
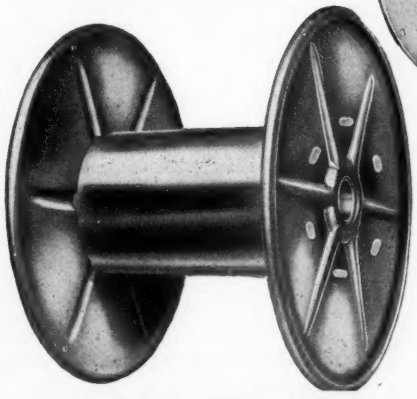


For Annealing and Handling Fine Wire



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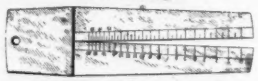

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Domestic Exports of Iron and Steel Wire, Wire Rope and Wire Nails, From the United States, By Countries

March 1927

Countries	Plain iron or steel wire	Galvanized wire	Barbed wire	Wire rope	Insulated iron or steel wire and cable	Wire nails
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Azores & Maderia Is.	.....	.....	.....	.....	.....	48
Denmark & Fr. Is.	.....	.....	.....	.....	263	.....
Finland	500	.....	.....	.....	.....	.....
France	4 618	.....	.....	.....	80	.....
Netherlands	10,000	.....	.....	.....	.....	.....
Norway	300	.....	.....	.....	.....	.....
Portugal	1,894	.....	.....	.....	.....	.....
Sweden	.....	.....	.....	882	.....	.....
Switzerland	200	.....	.....	.....	.....	.....
Turkey in Europe	.....	.....	.....	.....	.....	30
United Kingdom	136,035	1,184	.....	.....	9,087	69,640
Canada	814,059	3,467,639	1,585,936	72,548	44,294	10,994
Guatemala	10,000	3,350	151,905	835	195	24,285
B. Honduras	3,911	.....	5,780	258	.....	1,500
Costa Rica	1,052	11,492	.....	7,340	.....	14,811
Honduras	930	1,960	189,232	1,641	.....	52,409
Nicaragua	65	288	.....	925	80	4,130
Panama	3,785	9,300	69,600	4,816	.....	18,279
Salvador	.....	1,300	167,000	.....	4,349	12,300
Mexico	391,962	168,197	1,006,477	138,970	51,456	115 869
Newfoundland & Labrador	100	.....	2,500	.....	.....	11,535
Bermuda	150	.....	6,266	897	.....	1,800
Jamaica	1,375	145	40,600	.....	.....	5,800
Trindidad & Tobago	.....	1,350	.....	1,579	.....	1,000
Other B. W. Indies	.....	2,881	6,000	3 736	100	20,114
Cuba	87,309	68,940	140,800	30,769	1,670	366,563
Dominican Rep.	.....	4,547	60,650	1,696	.....	83,070
D. W. Indies	397	50	300	556	.....	4,000
Haitian Republic	3,167	1,238	9,125	.....	32,365	12,449
Virgin Is. of U. S.	.....	3,600	6,500	.....	.....	1,500
Argentina	330	.....	1,166,674	32,902	.....	.....
Bolivia	2,004	.....	.....	12,807	.....	200
Brazil	48,285	2,450	531,129	12,926	.....	.....
Chile	2,788	1,493	.....	29,904	1,989	4,154
Colombia	46,546	55,298	675,506	11,495	6,120	235,497
Ecuador	.....	2,786	36,000	.....	.....	.....
B. Guiana	.....	560	.....	.....	.....	.....
D. Guiana	.....	.....	.....	1,350	.....	.....
Paraguay	.....	.....	.....	3,659	.....	.....
Peru	23,128	18,580	.....	10,775	.....	20,042
Uruguay	39,683	49,000	.....	.....	.....	.....
Venezuela	198	23,894	264,261	4,512	178	89,605
B. India	51,071	.....	.....	48,544	522	300
B. Malaya	.....	.....	7,000	7,840	.....	.....
China	67,200	5,949	6,400	.....	.....	400
Java & Madura	.....	273	75,783	.....	.....	.....
Hongkong	.....	.....	.....	331	.....	.....
Other D. E. Indies	1,100	.....	118,689	.....	.....	.....
Japan inc. Chosen	24,434	446	.....	2,830	93	4,441
Kwantung leased territory	.....	340	.....	.....	.....	.....
Philippine Is.	37,846	109,767	367,500	176,778	.....	12,031
Soviet Russia in A.	.....	.....	.....	.....	536	65,300
Australia	49,582	69,054	.....	7,231	27,480	530
B. Oceania	.....	231	2,240	.....	.....	9,606
F. Oceania	.....	.....	.....	90	.....	1,500
N. Zealand	6,695	.....	.....	.....	5,776	100
Belgian Congo	.....	.....	.....	.....	.....	1,000
B. E. Africa	.....	.....	.....	4,684	2,816	.....
B. S. Africa	4,140	500	36,000	.....	2,809	.....
Liberia	.....	.....	.....	.....	.....	2,400
Other Portuguese Africa	.....	.....	.....	13,061	.....	.....
Total Quantities	**1,876,839**	**4,087,742**	**6.736,193**	**649,167**	**192,258**	**1 279,232**
Total Values	**109,337**	**126,988**	**214,319**	**86,921**	**30,106**	**52 605**

Shipments From the United States to Non-Contiguous Territories

	6038 Wire		6092 Wire nails	
	Pounds	Dollars	Pounds	Dollars
Alaska	2,698,293	260,129	363,102	17,100
Hawaii	428,168	30,683	292,795	13,903
Porto Rico	244,609	13,368	169,520	6 244

Swedish Wire Rods

(*Continued from page 224*)

stands up against corosion better than steels of less purity.

Music wire is a trade name for highest class of Swedish steel rods in carbon around 0.90%. The origin of the name is probably the use of this wire for piano cords. Yet the major part of music wire goes for all kinds of springs, which are made out of the cold drawn wire without hardening and tempering.

For other springs alloyed

Domestic Exports of Iron and Steel Wire, Wire Rope and Nails, From the United States, By Countries

April, 1927

Countries	Plain iron or steel wire	Galvanized wire	Barbed wire	Wire rope	Insulated iron or steel wire and cable	Wire nails
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Belgium	5,625	.....	.....	.....	.....	.....
France	.....	.....	.....	112,284	.....	.....
Germany	.....	.....	.....	171,179	.....	.....
Greece	20,160	.....	.....	.....	.....	.....
Italy	2,372	.....	.....	.....	.....	2,500
Netherlands	.....	.....	.....	.....	138	.....
Norway	6,000	.....	.....	.....	.....	.....
Portgual	1,712	.....	.....	.....	.....	.....
Sweden	500	.....	.....	.....	.....	.....
Switzerland	150	.....	.....	.....	.....	.....
Turkey in Europe	33,620	.....	.....	.....	.....	900
United Kingdom	114,970	3,634	11,200	.....	9,054	36,288
Canada	1,090,074	3,007,263	1,022,673	92,534	6,405	36,692
Brit. Honduras	.....	2,625	.....	.....	.....	.....
Costa Rica	8,400	4,235	.....	.....	.....	11,735
Guatemala	2,500	43,494	144,925	9,231	608	7,725
Honduras	.....	74,517	77,788	1,738	7	25,865
Nicaragua	.....	.....	42,585	7 068	1,200	18,300
Panama	24	925	2,190	27,655	2,569	29,566
Salvador	39,292	39,749	.....	359	.....	13,250
Mexico	340,414	238,250	884,731	109,848	7,967	49,876
Miquelon & St. Pierre	.....	.....	1,500	.....	.....	6,700
Newfld. & Labr.	79	121	.....	550	.....	5,705
Bermuda	667	463	.....	.....	.....	500
Barbados	.....	.....	.....	864	.....	7,000
Jamaica	.....	799	1,184	.....	1,592	3,000
Trinidad & Tobago	22,370	10,038	.....	6,480	237	1,000
Other Brit. West In.	.....	2,413	1,046	2,836	.....	8,550
Cuba	45,517	12,796	430,313	43,393	4,933	121,982
Dom. Republic	1,600	92,475	89,300	635	.....	72,820
Dutch West Indies	.....	2 863	.....	.....	.....	8,387
Haitian Republic	.....	.....	8,000	.....	132	54,845
Virgin Is. of U. S.	.....	.....	.....	.....	.....	4,000
Argentina	224,500	2,000	1,374,481	44,925	6,076	.....
Bolivia	.....	.....	.....	.....	10,220	.....
Brazil	208,436	75,054	2,093,956	8,995	.....	14,258
Chile	4,902	1,535	40 000	71,908	.....	40,500
Colombia	104,813	36,155	684,219	94,217	7,921	389,965
Ecuador	3,700	1,037	12,840	.....	297	.....
British Guiana	.....	.....	.....	930	.....	.....
Dutch Guiana	100	.....	2,500	.....	.....	3,762
Paraguay	10,000	.....	.....	.....	.....	.....
Peru	16,458	120,122	48,376	71,538	460	87,135
Uruguay	8,111	.....	.....	963	.....	.....
Venezuela	492	14,937	62,500	27,743	207	36,926
British India	43,450	.....	210	9,665	.....	.....
British Malaya	.....	.....	72	6,400	.....	.....
China	.....	3,945	.....	.....	.....	2,200
Java & Madura	250	.....	128,970	.....	.....	.....
Other Dutch E. Ind	.....	6,612	272,995	51,000	.....	.....
Hongkong	.....	115 800	.....	4,109	.....	.....
Japan, inc. Chosen	72,149	.....	.....	4,113	.....	17,000
Philippine Is.	106,418	11,520	505,850	82,442	2,260	256,164
Turkey in Asia	4,480	.....	.....	.....	.....	.....
Australia	140,054	41,341	35,840	8,110	.....	9,608
British Oceania	.....	8,960	14,200	1.106	.....	1,282
French Oceania	.....	.....	.....	1,400	.....	3,278
New Zealand	550	.....	.....	890	.....	255
Brit. South Afr.	1,621	100,000	1,572,180	.....	922	.....
Egypt	.....	145	.....	.....	.....	.....
Liberia	100	.....	.....	.....	.....	15,200
Port. East Afr.	.....	.....	309,800	.....	.....	.....
Total Quant.	**2,686,630**	**4,075,823**	**9,876,424**	**1,077,108**	**63 205**	**1,404,719**
Total Values	**133,488**	**120,331**	**305,588**	**149,837**	**11,127**	**51,214**

Shipments from the United States to Non-Contiguous Territories

	6083 Wire		6092 Wire Nails	
	Pounds	Dollars	Pounds	Dollars
Alaska	6,447,513	552,062	574,235	26 792
Hawaii	245,724	25,277	110,050	5,902
Porto Rico	180,296	12,888	166,404	5,103

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Woven Wire Netting

(*Continued from page 242*)

the surplus wire from the tightening is transposed backward to the lifting dies to be used in forming the loops. Thus, the metal of the wires is not stretched and the wire cross section not changed except at the crimps.

When the tightening dies come together on the length wires, pressing them to the cross wires so hard as to crimp them, it is evident that they could not bind any tighter. As the tightening dies press on the length wires top and bottom between each pair of cross wires, it puts set in the lengthwise wires midway between the cross wires, thus keeping them hard against the cross wires after the dies have left them.

Thus the process amounts to this, big alternate loops are made, cross wires are put in two at a time, cut to correct length, the big loops compressed down as small as possible, crimps in both length and cross wires keeping these in their correct accurately-spaced positions, after the spacing bars have forced the wires to those positions. The final compressing is important for this determines the appearance of the wire after leaving the machines and its permanence of shape and weave.

Galvanization of Iron and Steel Wire

(*Continued from page 235*)

at a speed of 3 to 6 meters per minute, run at a velocity of 2 to 3 revolutions per minute. The commonly traded wire, however, can be spooled at speeds running up to 8 to 20 revolutions per minute as it passes the bath at a speed of 14 to 35 meters per minute. Tie and lead-wire can be zinced and spooled at still higher speed as it is heated much quicker. Some zinc such wire at a speed of 100 to 150 revolutions per minute and spool it at a velocity of 100 to 250 revolutions per minute. One commonly increases the velocity of the spools in proportion to the decrease in the diameter of the wire. The various zincing plants usually employ their own, slightly modified methods. Some use short tubs and low speeds, while others prefer long tubs and high speeds.

Various methods are applied to secure firm adhesion of the coating—powdering of bath surface with ammonium chloride has long been in favor, although, more recent tendencies point toward a compound of ammonium and zinc-chloride. The application of ammonium chloride —commonly used for soldering purposes—assures a chemically pure surface of the wire. Dipping of the wire into a solution of zinc-chloride has also been endorsed as it almost guarantees firm adhesion of the coating. The well known fact that slightly coppered wire can be easily zinced serves as basis for another method. It is used by some American firms who run the wire through three tubs. The first one contains diluted sulfuric acid, and the second one a solution of copper sulfate, and the third one a solution of zinc-chloride. An admixture of aluminium and bismuth, too, increases the brightness of the coating. An addition of 0.25% copper to an aluminium containing bath is also said to increase the brilliancy of the zinced wire. Aluminium is added in form of an aluminium-zinc-alloy which has to be separately prepared and which is poured slowly into the bath. As little as 0.1% aluminium produces a bright lustre. The total quantity of this metal, however, should not surpass 0.25%. Aluminium is said to make the bath thinly liquid, a property which is due to its deoxidizing influence and its capacity to accelerate the disengagement of ferruginous zinc-alloy. Aluminium contain-

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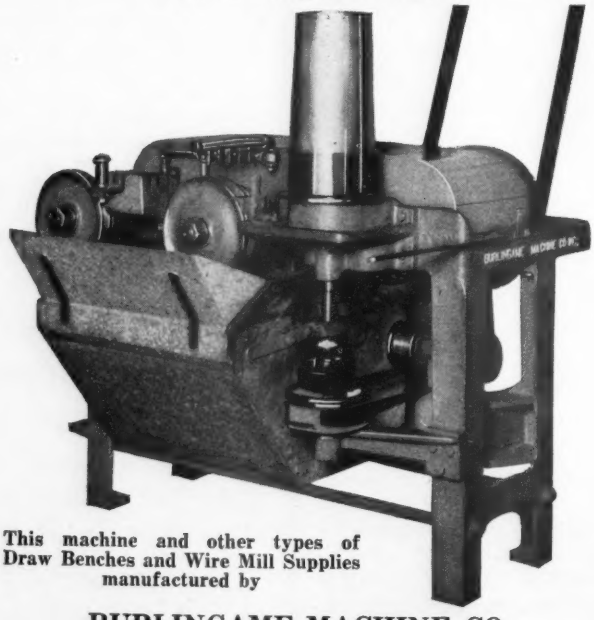

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ing baths are even at low temperature sufficiently fluid, a feature which permits keeping the liquid zinc always relatively cool and thus reduces the formation of iron-zinc-alloy.

Again another method produces a high lustre by running the wire from the zinc directly into a water-bath. This sudden colling-off prevents oxidation, but can not be applied to steel wire. This bright lustre can also be obtained by running the wire through the drawing-bench after it has been zinced. It usually is done after the skimming and before the wire is finally spooled. The wire is but slightly drawn so as to smoothen and polish the rough coating.

Telegraph wire, wire nettings, and barbed wire commonly are manufactured from annealed ingot iron. It is most advisable to condense annealing, pickling, and zincing into one unified process. The procedure is as follows: The wire runs through a heated muffle furnace, is cooled off, passes the pickling trough or a battery of troughs each one containing a solution hydrochloric acid of slightly greater intensity, enters the zincing tub, and is finally spooled upon reels. Figure 4 shows the arrangement of such a plant which has a capacity of 16 wires. One builds such plants with capacities ranging from 12 to 50 wires as they combine various advantages. The muffle-furnace e. g. suggests the installation of heat-generators and recuperators thus facilitating a reduction of coal consumption which runs from 6 to 10 per cent.

We already mentioned the formation of ferruginous-zinc-alloy. This alloy originates chiefly from the solution of the tub walls which is caused through the liquid zinc, but also from the solution of the dipped iron wire under the influence of the hot bath.

This formation of ferruginous-zinc-alloy increases in proportion to the increasing temperature of the bath. It is for this reason that one does not heat the tubs over an open fire.

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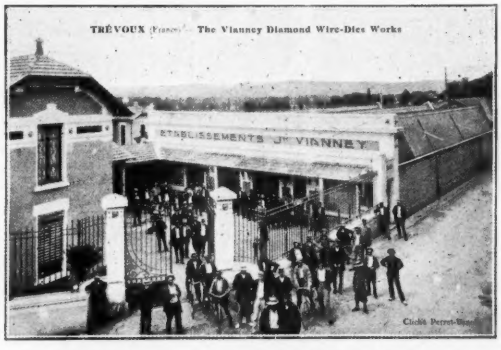

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The best suited temperatures are between 440 deg. C and 480 deg. C. Relatively large capacity of the tubs is the very best protective against excessive formation of ferruginous-zinc-alloy. A large tub always acts as heat-accumulator and prevents sudden or rapid heating of the zinc. The temperature of the bath is measured by pyrometer. Proper arrangement of the recording voltmeters permits continuous measuring of the temperature and close observation of the entire process.

The ferruginous-zinc-alloy ($FeZn_7$ and $FeZn_3$) is deposited on the bottom and on the walls of the tub. These layer-like deposits protect the walls against further dilution as the percentage of iron in the bath (10 to 12 %) exceeds the percentage of iron contained in the "layers," which contain but two ar three per cent. Figures 5 shows an enlarged piece of ferruginous -zinc-alloy. The bright spots are zinc-crystals upon the dark background of the ferruginous-zinc -alloy deposits.

The sediment on the bottom of the tub which is caused by the dipping of the wire has to be removed once or twice per week. It is replaced by pure zinc in order to check the formation of ferruginous-zinc-alloy and to assure smooth coatings. One also has attempted to control the formation of ferruginous-zinc-alloy by coating the tub walls with a mixture of clay and water-glass and by plating the bottom of the tub with lead. Although the melting point of lead is about 100 degrees lower than that of zinc (325 C against 420 C), the specific gravity of the former exceeds (10.6 against 6.5) that of the liquid zinc, and remains consequently on the bottom of the tub, even so, the higher melting point of the zinc filling necessitates temperatures which range above the melting point of the lead. The addition of lead does not cause any considerable alloy formation. The liquid lead also serves as an excellent heat accumulator for the zinc above it. In this arrangement

less zinc is used and the formation of the ferruginous-zinc-alloy is reduced. The nominal amount of iron-zinc-alloy that is formed swims above the lead and can easily be removed. Zinc and lead form but little alloy and the losses so caused are not worth mentioning. We shall later on show how one takes advantage of this alloy formation. The wire generally does not reach the lead-zone or passes it when still too cold to combine with the lead. Figure 6 is a reproduction of a lead-filled zincing tub after Turnbull. The lower parts of the tub (approximately two-thirds) contain the lead filling, and the upper parts are lined with fire-brick. A fire-brick shutter facilitates regulation of the thickness of zinc-layer. The actual operation process is as follows: the zinc-layer through which the wire passes into the bath is kept thinner than the zinc-layers through which it leaves the tub. The wire runs through the thin layer, is heated in the liquid lead, and actually zinced when passing through the thicker layer before leaving the tub. This method is said to reduce the formation of ferruginous-zinc-alloy from the wire and to eliminate it from the tub walls. Turnbull claims to have used such a tub for more than nine months without noticing the slightest corrosion and that he reduced the formation of ferruginous-zinc-alloy to 3 per cent. This percentage must be considered as being unusually low when compared with the results of other methods.

Increasing temperature not only increases the formation of ferruginous-zinc-alloy, but also that of zinc-ashes. The latter is a product of oxidation and is a very poor conductor of heat. It swims upon the surface of the bath and partly protects the zinc against further oxidation and sudden cooling off. Excessive accumulations of zinc-ashes have to be removed several times a week. It is customary to remove it before commencing operations as it preserves the temperature of the bath. The

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high percentage of pure zinc in iron-zinc-alloy and zinc-ashes permits their utilization for the manufacture of zinc-white. Turnbull weighed over a long period of time the iron-zinc-alloy and zinc-ash deposits of thickly zinced wire. The formation of ferruginous-zinc-alloy (containing 4% iron) amounted to 3000kg annually per sq. meter of zinc-covered tub. This experiment has been performed with a coke-heating tub and includes the deposits on the tub, the guide-bars, and the wire iteslf. He estimates that about 750kg, or 25% of the deposits, settled on the tub walls. Others confirm the reliability of these measurements. The annual formation of zinc-ashes (containing 66% zinc) ran up to 3000kg per sq. meter zinc-surface. Both experiments demonstrate the great waste of zinc through the formation of the mentioned byproducts. Turnbull's investigations covering zincing processes of unskimmed wire show that from 100 tons of zinc but 80% are actually needed for zincing, 18% (containing 68% pure zinc) are transformed into ferruginous-zinc-alloy, and 2% are lost through evaporation or neglect. The proportion between the actually utilized zinc and the waste consisting of ferruginous-zinc-alloy becomes still more unfavorable (the latter sometimes runs up to 50%) if the wire is skimmed. The quantity of the disengaged ferruginous-zinc-alloy as well as that of zinc-ashes depends upon the size of the tub and is not subject to substantial fluctuations.

Turnbull also conducted an investigation covering the thickness of zinc-coating when applied under the hot-zincing process. Table 3 shows that the thickness of such coats decreases in proportion to the decreasing diameter of the wire.

The coats are not of uniform thickness. This thickness varies with varying diameter of the wire. This is one of the points which are frequently overlooked by cost estimation.

The described hot-zincing processes also are applied to wire-nettings, wire-tacks, screws, and rivets, and are usually performed by one establishment.

The second part of this article will appear in the August issue of Wire and Wire Products.

Relation of Steel Quality to Drawing

(*Continued from page 229*)

cleaned. This assumption turned out to be correct, for examination of the sludge from the bottom of the cisterns showed this to contain crystals similar to those which had been actually separated from the solid steel. Whilst this result can be taken as being somewhat confirmatory, perhaps it would be unwise to attach too much importance to it on account of the possibility of the crystals coming from other sources.

FIG. 35.—Specks in steel due to very large additions of aluminium. ×100. (Reduced to ½.)

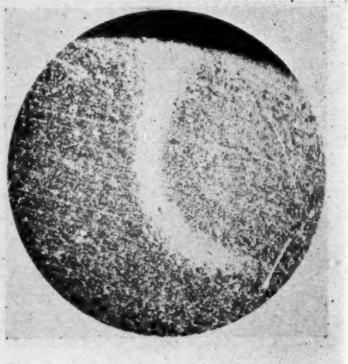

FIG. 36.—A roak in wire rod. ×100. (Reduced to $\frac{8}{11}$.)

The results of the tests and examinations carried out certainly prove that where aluminium is used as a deoxidiser the resulting inclusions have the most pernicious influence in causing wire to "run out" of size through the grinding out of the hole in the drawplate; but it should be understood that they are only one of the causes of the grinding action. Many cases of the "running out" of wire, in which it can be definitely proved that aluminium was not added to the steel during its manufacture, have been traced, and careful examinations of these casts show that the minute specks are no doubt manganese-iron silicate, and are, of course, more difficult to get rid of in the process of steelmaking than the alumina specks.

The alumina crystals have not yet been detected in a steel which could be definitely proved not to have been treated with aluminium, but in consequence of the recent coal stoppage it has not been possible to carry out prolonged tests. Further work may give results of a definite character.

Besides causing trouble in wire-drawing, the minute hard specks are no doubt one of the causes of the rapid wear of the edges of screwing and other cutting tools when steel of this character is being worked.

In concluding with steel which causes "running out" in wire, it is only fair to say that wire will sometimes "run out" of size for reasons quite apart from the quality of steel.

Next installment of this article will appear in the August issue.

Making of Wire Rods

(*Continued from page 232*)

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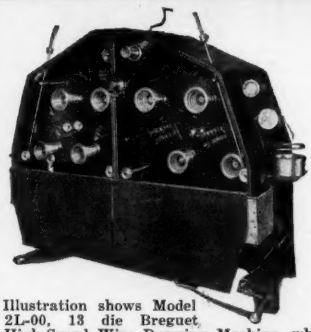

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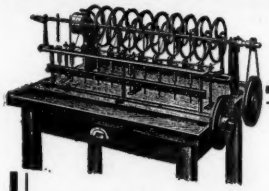

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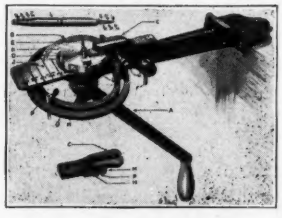

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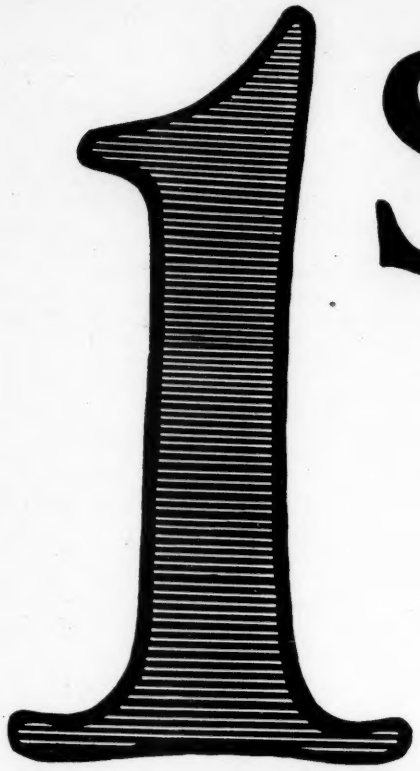

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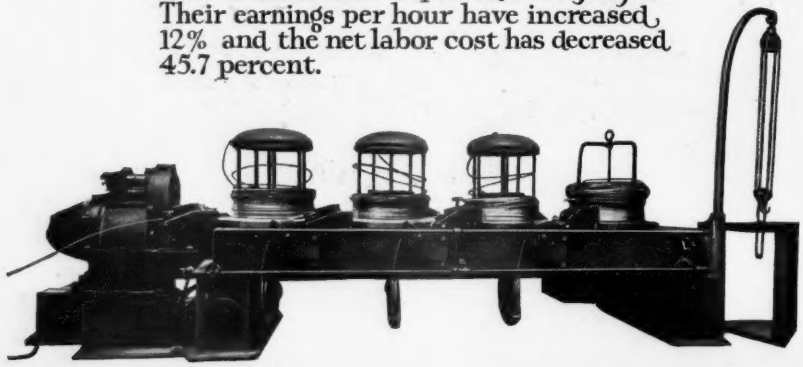

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